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# Making a Pattern for a Parsons Steam Turbine

*A Discussion of the Details of This Work Which Was Facilitated Greatly by the Use of a Universal Woodworking Machine*

By C A Tupper

WHILE the making of wood patterns for the shaping of metal parts is so old an art that it seems as if little that is new could be added to the current knowledge, still with the design of each new piece of apparatus different methods are required to get the most accurate, economical and satisfactory results. Consequently, it may be of interest to follow, in more or less detail, the pattern-construction methods now being employed in a large shop when making a steam turbine pattern.

The pattern shown is that of a low pressure steam turbine of the well-known Parsons horizontal type. As the cylinder or barrel presents features of the greatest interest, that only will be considered; the making of the patterns for the tail piece and spindle bearings offers little that is different from ordinary practice in making numerous other machinery parts.

In the securing of a good finished product it is, of course, essential to have a pattern that is satisfactory from every standpoint, and this can only be secured by the use, in the first instance, of the best lumber; pine of the grade known as clears is, therefore, used. It is kiln-dried and planed on both sides, and then set on edge with air spaces on all sides, in brick-concrete storage rooms adjacent to the pattern shop. This brings the lumber to the patternmaker completely seasoned and fit to be used in making a turbine pattern.

The drawing showing the finished dimensions of the turbine comes from the sales office, through the engineering department, with the order for the pattern. From this the various parts to be made are laid out in full-size section on boards. The lay-out is made with shrink rules, 1/12 inch to the foot being allowed on all dimensions over 3 feet and ⅛ inch on all dimensions under that. For finishing purposes, allowances of ⅛, ¼ and ⅜ inch are made, depending on the location and character of the surface. During the construction of the pattern care is taken to leave space enough at various places to provide for the swelling of the wood which occurs when it is in contact with damp molding sand.

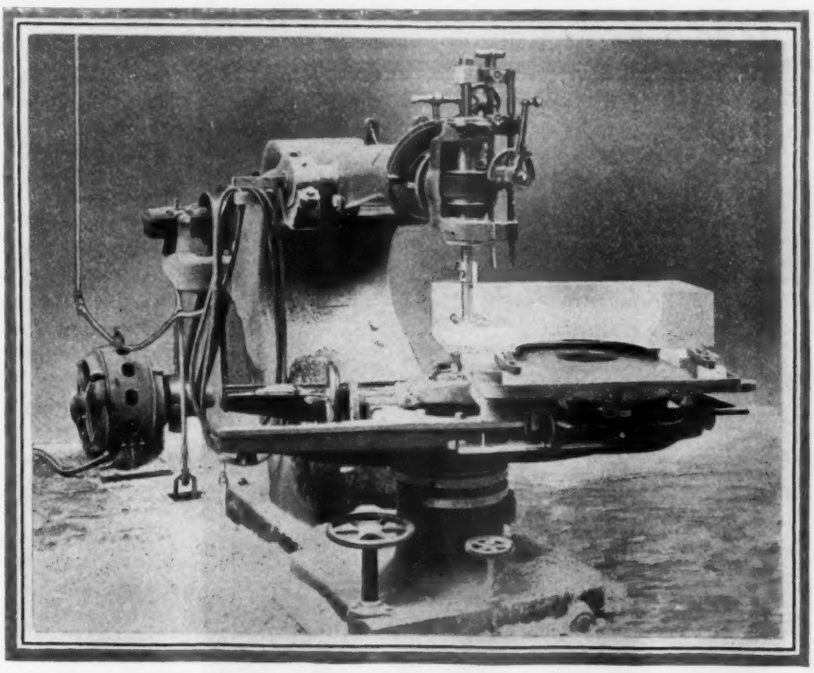

FIG. 1—UNIVERSAL WOODWORKING MACHINE CUTTING A TURBINE CORE BOX

After the various layouts are completed they are assigned to different workmen so that each may complete his section. The parts in this case were: Body of turbine cylinders, two nozzles for cylinder, main core box for cylinder and core boxes for nozzles, or nine parts in all. As the two halves of the turbine cylinder are exactly alike except for the nozzles, a pattern for one-half the body of the cylinder is made and detachable noz-

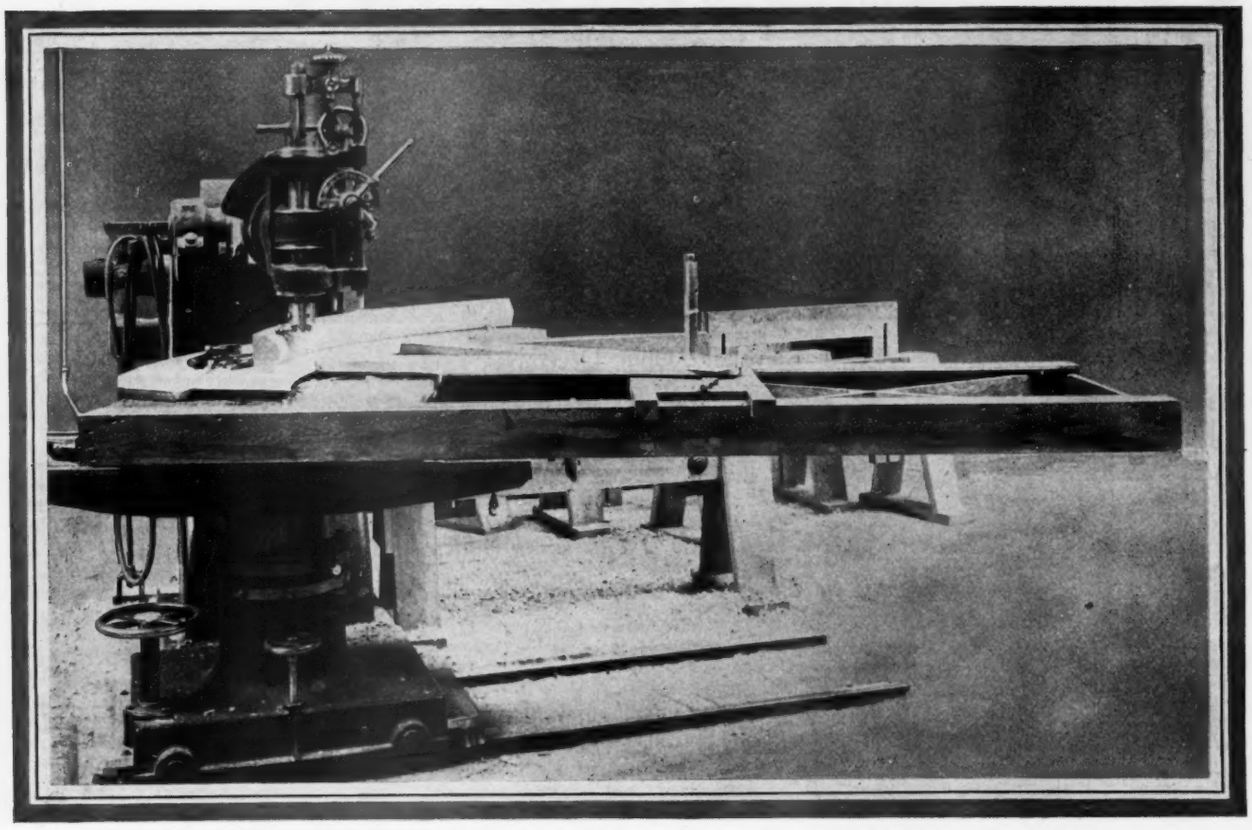

FIG. 2—UNIVERSAL WOODWORKING MACHINE WITH SPECIAL EXTENSION AND PLATES

zle patterns are used on it. Throughout the pattern the most substantial construction is used. All the permanent parts are fastened together with glue and screws. The holes for all screws are bored with an electrically-driven boring tool.

The base on which the half cylinder pattern is built, as shown in Fig. 3, forms the parting line. It is made of three 1¼ x 12-inch planks, 4 feet long, with additional pieces secured around the edges to bring the whole to the proper thickness of the flange. These are held together by five cross pieces to which they are firmly glued and screwed. On the base thus formed the plan is drawn, the bolt holes laid out and the flange outline cut on the band saw. The circular parts of the pattern, as shown completed at each end, are then built-up of segments sawed from 1¼-inch lumber and screwed and glued together. After the circular parts are placed, the thick pieces, notched for nut clearances, are fitted to each side, between the circular parts. These two pieces are fastened to the base and the space between them is covered by a board that serves to strengthen the pattern and acts as a guide for the nozzles.

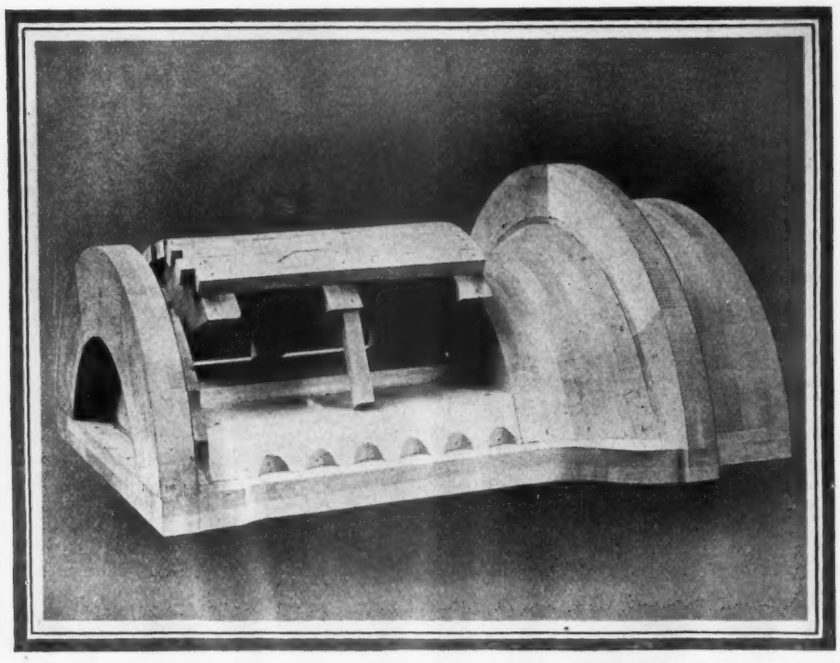

FIG. 3—PATTERN OF A STEAM TURBINE CYLINDER PARTIALLY COMPLETED

*Making Nozzles*

On the main part of the pattern thus made are fitted the interchangeable nozzles, one being the admission nozzle and the other the valve nozzle. Both are fitted onto similar bases, one of which is shown in Fig. 3, with a block under one side. In making these bases three forms are made by gluing and screwing together 1¼-inch pieces and on these the staves are fastened. These pieces are built-up in place and are then planed to conform to the required shape.

The valve nozzle, shown partially completed in Fig. 6, is built-up of segments and turned in a lathe. The segments are 1¼ inches thick and 3½ inches wide. As shown, the flange

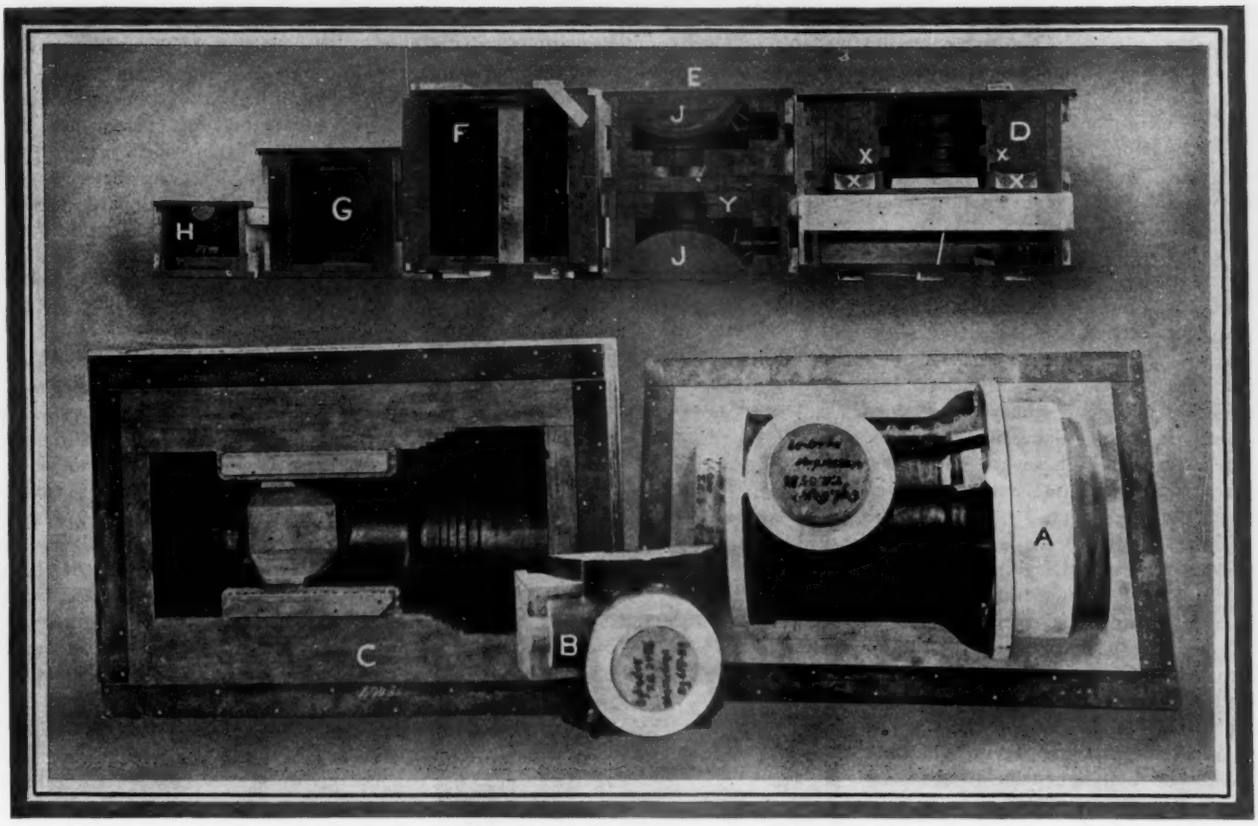


FIG. 4—PATTERN AND CORE BOXES FOR A TURBINE CYLINDER

is made in six segments and is secured loosely to the main body of the nozzle by dovetails. These dovetails hold the flange in position while the mold is being rammed, leaving the flange segments in the sand when the pattern is drawn. One joint of the flange is made a miter joint instead of a radial, which permits the drawing-in of that section, after which the rest are easily drawn. The nozzle, as turned, is then fitted to the base previously prepared.

The admission nozzle shown at *B*, Fig. 4, is quite different from the valve nozzle, but is built in much the same way. This nozzle is shorter than the other and has no flange. As shown, it is fitted with an auxiliary admission pipe for supplying live steam when necessary. On a base similar to the one used for the valve nozzle, are fitted the admission nozzle, auxiliary admission and special core print.

*Fitting Nozzles*

After being completed to this point the nozzles are placed on the main body of the pattern and the supporting ribs are carefully fitted on and firmly fastened in place. All corners are then filled with leather fillets of ample radius. Core prints, built-up of 1¼ x 3½-inch segments, are then fastened to each end of the main body of the pattern, as shown. In the bottom of the pattern are fastened iron draw plates with threaded holes that permit the insertion of a screw eye. By this means the pattern can be lifted by a crane, or, if necessary, by hand. The drawing plates are so located that when the pattern is lifted by the screw eyes it is in practically perfect balance.

In the bottom of the pattern are also fastened three iron plates having projecting pins. These pins hold the pattern in a fixed position on the matchboard and make all molds come in the same relative position. The matchboards have sockets into which pins, on the cope of the flask, fit. The matchboard is shown supporting the pattern at *A*, Fig. 4. It is made extremely strong to withstand the shocks that it gets in molding, and it is protected by strips of boiler plate that are placed around the edges.

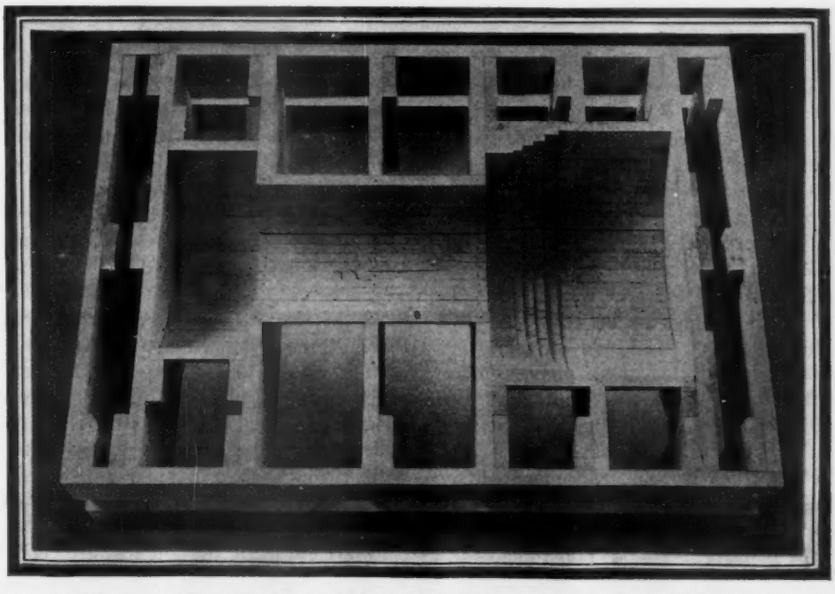

FIG. 5—CORE BOX OF A STEAM TURBINE PARTIALLY COMPLETED

In Fig. 5, and at *C*, Fig. 4, is shown the main core box. A very strong, rigid method of construction is employed, so that there is no possibility of the box being racked out of shape. The supporting and bracing members are all of 2-inch material. Fig. 5 shows the method of construction very plainly.

The cross members are sawed to the requisite shape and supporting forms are put in where necessary. On these shapes, 1⅛-inch staves are fastened and their inside makes the box the proper radii after sandpapering. At the end where the stepped section is shown several layers of strips are used. These are cut to the correct form and one set is fastened on top of the other.

The top of the box is then finished as shown at *C*, Fig. 4, and the core print for the nozzle core is placed. Around the outside edges of the top are placed pieces of boiler plate which protect the face of the box. Holes are placed in these which fit pins on the drag of the flask. The core is made in the drag on a jarring machine so that it can be fitted to the cope and makes the complete half of a turbine cylinder.

*Nozzle Cores*

At *D*, Fig. 4, is shown the core box for the valve nozzle. There is an annular section around the main barrel of the cylinder which permits the steam to flow from the admission nozzle to the valve nozzle. The core for this section is made in conjunction with the cores for the nozzles. This valve-nozzle core is made in halves and the same core box is used for each half. Interchangeable parts are provided so that either a right hand or left hand half can be made. Those parts which are marked *X* are the ones that can be changed.

Certain parts of this box have an irregular curved section that is worked out on the universal woodworking machine, as shown in Fig. 1. This is one of the most useful and economical machines on the market for pattern shop use.

It can be driven directly by a motor attached to the main shaft or through belting as in this case. A 5-horsepower, 1,130-revolution per minute, 60-cycle, three-phase induction motor is mounted on the floor and is belted to the shaft of the machine. A potential starter for controling the machine is mounted on the wall. Cone pulleys provide for speed variations.

The movements of the head and table will permit of the cutting tool being brought into practically any position relative to the work on the table. This, coupled with auxiliary attachments to the table and a large assortment of cutting knives, permits of almost any kind of work being performed.

By means of a supplementary top for the table it is possible to cut true circular patterns. If the radius of the circle is greater than the clearance of the machine, when the table is set with its center directly under the spindle, the work can be done in segments and turned with the top of the table, which in its case would be moved laterally on its track. Work up to 4-foot radius can thus be handled.

For work of longer radius, wooden frames have been arranged, as shown in Fig. 2, which are supported at one end by the table and at the other

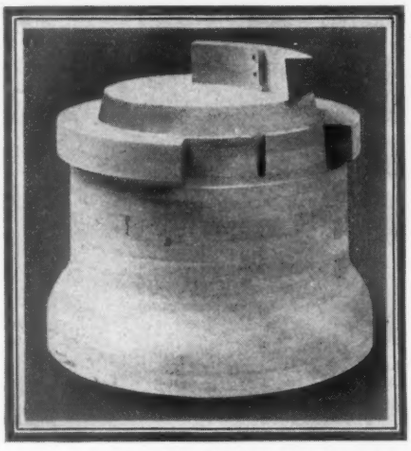

FIG. 6—PATTERN OF STEAM NOZZLE OF TURBINE, SHOWING METHOD OF FASTENING

by a horse. It has a movable slide carrying a staff which is in line with the cutting spindle and which serves as a center about which to revolve work.

This device can also be used for work which is too large to be carried by the table, but which will clear the frame. Draft can be given the work by tilting the head to the desired angle. For the larger radii a tool is ground to the correct radius and its position changed at the end of each cut.

In this latter case a hole is drilled through the tool, which is put in the holder and a belt is passed through to clamp the two sides of the holder tightly together. This makes the adjustment of the tool easy and also holds it in such a manner that there is no possibility of its flying off if it should come loose.

Referring again to Fig. 4, the core boxes, *E*, *F*, *G* and *H*, are all used in connection with the admission nozzle; *E* is the main box and is for the central core. The division is through the center line of the live steam admission pipe. This brings it off the center line of the nozzle and in consequence the loose piece, *Y*, is provided. After this is removed the box can be removed from the core. The small parts, shown with the pins in, form the guides for the entering live steam when that is used.

The core formed in box *F* fits the circular section shown at *J* in box *E*. The core is very easily and quickly made by sweeping-up with the sweep provided. In box *G* is made a core which is pasted to core *F*, and makes the opening to the annular chamber.

In box *H* is made the core for part of the live steam admission pipe and its support. A separate core is made for this section because of the fact that if it were made a part of the main pattern there would be difficulty in ramming the sand properly around it, in addition to the further trouble of having numerous removable pieces to delay molding operations.

These are the parts which must be made in wood before it is possible to secure a turbine cylinder. To indicate to the molder just what each surface is for, the different parts are shellacked different colors. Yellow is used for core prints, white for finished surface and black for rough iron.

After the workmen have completed the parts and the latter have been shellacked, the foreman carefully checks over all the measurements to see that the pattern has been correctly made and then has suitably numbered metal tags serve to indicate the machine for which it is a pattern and where it should be stored.

The design of the pattern and the method of making it all assist in decreasing the cost of the output. The substitution of a half cylinder pattern with interchangeable nozzles in place of a complete pattern, makes the pattern cost much less and does not in any way impair the accuracy of the casting. In fact, it improves it. The cost is reduced to the extent involved by the amount of the material and labor required in making the other half of the pattern.

The same can be said of core box *D*. Only a half box is used, with the consequent saving over the first cost of a complete box, while the quality of the complete core is fully as good as a solid core. Removable parts and substitute pieces, wherever advisable, reduce the cost of molding to a minimum, while the cost of the pattern is hardly increased, if at all.

# How to Melt Iron to Obtain the Best Results*

***The Conditions to be Observed in Operating the Cupola, With Suggestions for Making the Bed, Charging, Blast, Etc.***

By Richard Moldenke

UNLIKE the smelter and the blast furnace for the reduction of ores and production of mattes and metals, the foundry cupola furnace has only melting to do. While this looks simple enough and the development has progressed through centuries by cut-and-try methods, there is still much to be learned, and it takes a metallurgist to seek for the reasons underlying the production of defective castings when melting high grade materials.

There are still other differences to consider. The smelter is run continuously, the cupola rarely so. In the smelter there is some chance for experiment as rich slags can be returned again, while in the cupola the metal must be good for casting purposes from the first tap to the drop of the bottom, otherwise heavy damage will result. In the smelter the one object sought is the production of metals or mattes with a minimum loss in the slag, whereas in the foundry a variety of castings of different compositions must often be run from the same heat, one after the other.

### *Melting Zone*

Experience with the cupola has shown that it is necessary to have the melting done at one place throughout the heat. This is the place of maximum temperature and is readily noticed on looking at the lining by the heavy cutting action of the slag and iron oxide during the melting operation. The design and operation of the cupola must, therefore, conform to the point above mentioned. Once this has been attained, the other considerations resolve themselves into details of construction which will give the least trouble for repairs, with the smallest expense.

The very high temperatures required to melt iron and steel in the cupola, and have the metal sufficiently overheated for casting purposes, render it inadvisable to use water-jackets in the construction of the furnace. It is always possible to patch the lining at the melting zone between daily heats. The balance of the lining is seldom affected enough by abrasion and chemical action to require replacement oftener than once in nine months.

The cupola is practically a shell of steel lined with a refractory material of the proper kind, and provided with a set of tuyeres to allow air to be driven into the fuel and the charges to be melted. It should have the same diameter throughout, as there is no reduction of ore and consequent change in bulk of material to hold. The tuyeres are to be of an almost continuous type, as it is important to keep the belt of maximum temperature above them practically level. The tuyeres are placed at a point to permit of slagging-off below them.

### *Fuel Must be Burned Completely*

In cupola melting it is necessary to burn the fuel as completely as possible, in order to attain the maximum available temperature. That is to say, the carbon of the coke or anthracite — whichever happens to be used—must be converted to carbon-dioxide with as little subsequent change to carbon monoxide as may be possible. If this desirable condition is effected at the point where the metal charge has been placed, melting under the most favorable conditions ensues. The molten iron is superheated properly, and the chances of oxidation in melting are reduced to a minimum.

There follows from the above that in order to get the conversion of the fuel into the maximum amount of carbon dioxide, not only must the bed stop at the point where this is produced and no more fuel allowed over it, but the proportion of air blown into the cupola and the diameter of the cupola must stand in some fixed relation. It is well, therefore, to study the rationale of the process of combustion which takes place in a cupola. Let us suppose that a given cupola has had the bed charged and well-burned through, the first metal charge has been put on, and then the succeeding intermediate charge of coke which is intended only to replace that portion of the bed burned away in melting the first metal charge. The second metal charge is then put on, then coke, then metal, and so on. It is desired to start melting. The blast is put on, and this is what happens: As the air enters through the tuyeres into the fuel, every molecule of oxygen that touches the incandescent fuel picks up enough carbon to make a molecule of carbon dioxide, which travels upward through the incandescent bed. Some of the molecules of this carbon dioxide must naturally be changed to other molecules of carbon monoxide by their contact with more incandescent coke, but as there is a lot of free oxygen present, not to speak of the nitrogen molecules in great abundance, which serve to protect the finished $CO_2$ from becoming CO, it would take some time and space to travel through to change the bulk of the $CO_2$ to CO. As a matter of fact, the maximum proportion of $CO_2$, under ordinary conditions is reached at 18 to 24 inches above the tuyeres, the bed being sufficiently thick to allow this. If more incandescent fuel is above this then the change from $CO_2$ to CO is rapid, and the poor melting results quickly noticeable.

### *No Place Free From Uncombined Oxygen*

While the above described process is going on it will be seen that it is quite easy for some free oxygen to reach a considerable distance up into the charge before being used up in the combustion. In fact, tests on this point by the United States bureau of mines have shown conclusively that there is no place in the cupola absolutely free from uncombined oxygen. It was further found that a lot of the air practically escaped unchanged along the lining, where it is just in the right place to become oxidized as it gets into the melting zone.

A further interesting point proved by the investigations of the bureau of mines is that there is a central cone in the fuel bed of the cupola above the tuyeres in which there is a formation of CO only, showing that no combustion goes on at all there, which indicates that as the air is blown into the cupola it curves upward, and some of it does not reach

*Presented at the Cleveland meeting of the American Institute of Mining Engineers.

the center directly opposite the tuyeres. The smaller the amount of air going into the same diameter cupola the higher this cone will naturally be, and if it should extend beyond the original height of the bed, after melting for some time, by catching accumulations from the subsequent coke charges, there will be a diversion of the metal charges outward from the center as they descend, and the melting done in the cupola will be considerably less than the normal amount, besides forcing the cupola to melt in a very uneven manner. On the other hand, the more air blown into the same diameter cupola, the shorter becomes this cone, and it disappears altogether when the air is forced straight through the bed. This is about the ideal condition, and any further forcing of the air by using larger quantities, will unduly increase the melting capacity of the cupola, compelling the raising of the coke bed.

*Relation of Air to Size of Cupola*

This somewhat involved explanation shows why the amount of air blown into a cupola should bear a certain relation to the diameter of the furnace. Practice is the best guide to this. For instance, the ordinary cupola with a diameter of 54 inches inside the lining takes a little less than 30,000 cubic feet of air to melt a ton of iron. Under the best conditions of practice this cupola has been found to give 10 tons an hour, hence we must provide 300,000 cubic feet of air to go into that cupola, and see that it really goes in. It is possible to get good results with less air but then the melting rate drops and this is bad foundry economy. On the other hand, it is possible to get 11 or even 12 tons an hour from the cupola, but this means blowing in the corresponding amount of air with consequent chances for bad working.

There is, therefore, a safe rate of melting for each diameter of cupola. If a given cupola does not perform in accordance with this rate and the amount of air blown in has been found to be the correct one, then the trouble must be looked for elsewhere. As the blast goes through the fuel bed the gases become hotter and hotter up to the point of maximum proportion of $CO_2$, and this may be about 3,000 degrees Fahr., theoretically. At this point, which is from 18 to 24 inches above the tuyeres, the hot gases should find the charge of metal to melt. If there is fuel still above this point, by originally charging too much fuel, the conversion to CO takes place, with consequent reduction of the temperature. It will, therefore, be seen that from the actual entrance of the air into the bed, there is a rapid increase in temperature upward until the maximum is reached, and then a decrease. Experience shows that melting iron is possible for a distance of about 1 foot below this place of maximum temperature, and perhaps 2 feet above it, if the bed were allowed to be so low or so high through improper charging. This effect can be readily understood when it is remembered that the melting point of white iron runs as low as 2,000 degrees Fahr., while that of the gray irons is several hundred degrees higher. The iron melts, but in the case of too low a bed it will be insufficiently overheated besides having been exposed to free oxygen with all the troubles this brings about. In the case of too high a bed the metal has not been oxidized, but is so cold that even dropping through a hotter portion of the bed will not give it the proper temperature for casting.

Experience has taught us how to find the proper height of bed. This height is not a function of the weight of the fuel, but of the amount of travel through it that the air has to perform until the maximum $CO_2$ has resulted. It has been observed that when conditions in the cupola are just right for the blast to go on, which is to say when the bed is well burned through, and the cupola charged to near the top with the metal heating up satisfactorily, it should take between 8 and 10 minutes from the commencement of blowing until enough iron runs from the spout to necessitate closing up the tap hole. The melting iron dropping by the peep holes in the wind box will be observed in about 5 minutes after the blast is on, but it takes a little longer to have enough metal to begin running out. If, under these conditions, the metal comes in less than 8 minutes the bed is too low, and should be increased by charging a little more fuel between the metal charges in order to bring it up properly at the time this was observed, and the next day the bed should be made higher. If it takes longer than 10 minutes the bed is too high and should be correspondingly reduced.

Looking at the actual condition of the bed, we find that every portion of it below the tuyeres is simply so much filling intended to give storage space between the lumps of incandescent coke for the molten metal. Above the tuyeres we find the chemical reactions of combustion going on which result in maximum temperature conditions at a given point and at which melting should be done. It further will appear that only the upper few inches of this bed will be of the maximum temperature, and below this the bed is cooler and contains the dreaded free oxygen. Hence the metal charge should be so proportioned that it is melted down completely by the time about 4 inches of the bed have been consumed. The correctness of this statement can be observed at any time in looking into the interior of a cupola the morning after a melt. In a well-regulated shop the scoring of the lining is confined to a belt of from 4 to 6 inches. In a shop where the reverse conditions exist, the belt of affected cupola lining may be 3 feet high. The latter condition shows a shifting of the melting zone up and down according as the bed has been allowed to burn away before the succeeding charges of coke came down to replace it, or the bed had been allowed to run by charging too much coke between the charges of metal.

*Mistake Made in Charging*

The inferences that must be made from the above are that the smaller the charge of metal and the oftener repeated, the less the shifting of the melting zone up and down in the cupola and that it is a serious mistake to adopt the almost universal rule followed in this country, to make the first charge twice as heavy as the succeeding ones. Where this is done, it is patent that double the amount of coke must have been burned away from the top of the bed, only half of this being replaced by the intermediate charge of coke, and from the second charge of metal the melting is done at a lower point in the cupola. It is difficult to instill this point into the minds of cupola men and even chemists. They see a big pile of coke go into the cupola for the bed, and of necessity hold that a big lot of iron should go on it, forgetting that only the very upper portion of the bed does the work whether the bed is big or little. European practice is more rational in this respect, for not only are cupolas of small diameter used with consequent effective penetration of blast, but the charges are very small and there is no large first charge.

While the weight of the coke for the bed is not essential, it is a very important factor for the intermediate charges. That is to say, once the

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form

## STANDARD METHODS FOR DETERMINING THE CONSTITUENTS OF FOUNDRY COKE.

*Continued from Data Sheet No. 126.*

### *Phosphorus*

Ignite 5 grams of coke in a platinum dish or large platinum crucible until all the carbon is burned off, then add 10 cubic centimeters hydrochloric acid (1-1) and 20 cubic centimeters hydrofluoric acid and evaporate to dryness and ignite at a dull red heat. Fuse the residue with about 1½ grams of sodium carbonate and 2 grams of potassium nitrate. Cool, place the dish in a beaker of water and boil. Clean and remove the dish. Acidify the solution with hydrochloric acid, precipitate with ammonia, boil, filter and wash with hot water. Wash the filter with warm dilute nitric acid to dissolve the precipitate. Should it not dissolve, wash with warm dilute hydrochloric acid until dissolved. In the latter case, it will be necessary to evaporate to about 5 cubic centimeters, add 30 cubic centimeters nitric acid (1.20 sp. gr.); again evaporate to about 5 cubic centimeters and add 30 cubic centimeter nitric acid (1.20 sp. gr.).

After heating the solution to between 70 and 90 degrees Cent., add 50 cubic centimeters of molybdate solution. Agitate the solution a few minutes, then filter, and wash five times with a 3 per cent nitric acid solution, and five times with a 0.1 per cent potassium nitrate solution. Transfer the precipitate and filter to the flask in which the precipitate was made. Add 30 cubic centimeters water, then *NaOH* (*N*-5) from a burette until in excess, keeping the solution agitated. When the yellow precipitate is all dissolved, add 0.1 cubic centimeter of phenolphthalein solution as indicator, and then titrate with $H_2SO_4$ (*N*-5).

c. c. (*N*-5) *NaOH* = c. c. (*N*-5) $H_2SO_4 \times 0.0054$ = per cent phosphorus.

To make the molybdate solution, add 100 grams molybdic acid to 250 cubic centimeters water, and to this add 150 cubic centimeters ammonia. Stir until all is dissolved and add 65 cubic centimeters nitric acid (1.42 sp. gr.). Make another solution by adding 400 cubic centimeters concentrated nitric acid to 1,100 cubic centimeters water, and when the solutions are cool, pour the first slowly into the second with constant stirring and add a couple of drops of ammonium phosphate.



## USEFUL INFORMATION FOR THE BRASS FOUNDRYMAN

Specifications for non-ferrous alloys frequently state the component metals in *parts,* and for converting *parts* into pounds, the following table will be found convenient:

Table for Converting Parts into Pounds.

| Parts. Lbs. | Parts. Lbs. | Parts. Lbs. | Parts. Lbs. | Parts. Lbs. |
|---|---|---|---|---|
| 16 = 1 | 33 = 2 1/16 | 50 = 3 1/8 | 67 = 4 3/16 | 84 = 5¼ |
| 17 = 1 1/16 | 34 = 2⅛ | 51 = 3 3/16 | 68 = 4¼ | 85 = 5 5/16 |
| 18 = 1⅛ | 35 = 2 3/16 | 52 = 3¼ | 69 = 4 5/16 | 86 = 5⅜ |
| 19 = 1 3/16 | 36 = 2¼ | 53 = 3 5/16 | 70 = 4⅜ | 87 = 5 7/16 |
| 20 = 1¼ | 37 = 2 5/16 | 54 = 3⅜ | 71 = 4 7/16 | 88 = 5½ |
| 21 = 1 5/16 | 38 = 2⅜ | 55 = 3 7/16 | 72 = 4½ | 89 = 5 9/16 |
| 22 = 1⅜ | 39 = 2 7/16 | 56 = 3½ | 73 = 4 9/16 | 90 = 5⅝ |
| 23 = 1 7/16 | 40 = 2½ | 57 = 3 9/16 | 74 = 4⅝ | 91 = 5 11/16 |
| 24 = 1½ | 41 = 2 9/16 | 58 = 3⅝ | 75 = 4 11/16 | 92 = 5¾ |
| 25 = 1 9/16 | 42 = 2⅝ | 59 = 3 11/16 | 76 = 4¾ | 93 = 5 13/16 |
| 26 = 1⅝ | 43 = 2 11/16 | 60 = 3¾ | 77 = 4 13/16 | 94 = 5⅞ |
| 27 = 1 11/16 | 44 = 2¾ | 61 = 3 13/16 | 78 = 4⅞ | 95 = 5 15/16 |
| 28 = 1¾ | 45 = 2 13/16 | 62 = 3⅞ | 79 = 4 15/16 | 96 = 6 |
| 29 = 1 13/16 | 46 = 2⅞ | 63 = 3 15/16 | 80 = 5 | 97 = 6 1/16 |
| 30 = 1⅞ | 47 = 2 15/16 | 64 = 4 | 81 = 5 1/16 | 98 = 6⅛ |
| 31 = 1 15/16 | 48 = 3 | 65 = 4 1/16 | 82 = 5⅛ | 99 = 6 3/16 |
| 32 = 2 | 49 = 3 1/16 | 66 = 4⅛ | 83 = 5 3/16 | 100 = 6 ¼ |

proper height of the bed has been found for a given coke, the replacement of what is burned away in melting each charge is a definite function of its composition and somewhat of its cellular structure. Every time the brand of coke is changed it is necessary to try out the melting time for first iron, in fact in well-regulated shops this is done every day, unless the shop custom is to keep the breast closed during the *burning through* and *blast on*, when it is sufficient to make the above described time trial once a week. It is also necessary that the fuel for the bed should be perfectly dry, though this is not essential for the upper charges, provided due allowance is made for the water in weighing, as the carbon content is required in the right proportion.

It is, therefore, well to use another *experience* figure for the weight of the intermediate charges of fuel. This is one-tenth the weight of the metal charged above it and which it is to melt. A good, high fixed carbon coke can melt more than 10 times its weight, or the ratio is say 11 pounds of metal to 1 pound of coke, while a high ash coke works the other way. Hence we have got to the point where in trying out the melting conditions required for a cupola, the first iron is wanted at, say, 8 minutes, the first charge of metal as small as all the others, and the charges of coke between these metal charges one-tenth in weight. It now remains to fix the size of the charges of metal.

*Metal Charges*

Since about 4 inches of the coke bed only should be burned away in melting the metal charge above it before the next coke charge comes down, it is apparent that the proper size of the metal charge should be 10 times the weight of 4 inches thickness of coke in the cupola. The best way to ascertain this weight is to lay a ring of cupola blocks or fire brick on the cupola charging floor, of the diameter of the cupola, and 4 inches high. Fill this space with coke and weigh it. Ten times the weight is the amount of metal to be charged.

Inasmuch as during the course of a melt the cupola becomes hotter and the upper charges well heated, less coke is required between the charges, and here the experience of the foundrymen comes into play. The easiest method of determining this question is to observe the rate in melting. That is to say, if a given cupola melts 10 tons an hour for the first hour, and only 9 tons the second hour, a gradual and slight reduction of the intermediate charges of coke is in order until the melting rate is restored and even accelerated. Continued observation quickly overcomes this difficulty.

*Oxidized Iron*

Oxidized iron is very difficult material with which to obtain good castings. It seems that when the melting iron gets into portions of the cupola where free oxygen is present, it is affected thereby, and the result is a higher freezing point. The metal loses its life and cannot safely be held for any time. Moreover, it contains gases which come out at the moment of set, with the result that the castings show evidences of pinholes, heavy shrinkages, and even cracks from loss of power to accommodate themselves to internal strains while the metal is setting. And still worse, the pin holes often do not appear until the skin of the castings is removed by machining. The reason for this is that when the mold is poured, the metal immediately in contact with the sand sets first, and in doing so passes its contained gas through it. Once this skin has formed, further gases attempting to get out are shut off, rise to the top, and will remain just under the skin of the cope. Metal of this kind always shows defects when the cope portion is planed off.

Since this condition is entirely due to the oxidation of the metal, it is important that the charging of the cupola be done very evenly and regularly and not to charge the pigs around the lining and the scrap in the center.

The subject could be extended still further by giving many and varied examples from actual experience, but enough has been said to indicate that the cupola is by no means the simple contrivance that it is supposed to be, and that there are refinements in practice which take into account peculiarities in fuel, metal, and even the air used for combustion purposes.

*Conditions to be Observed*

In summing up the subject, the following conditions should be observed:

That the proper amount of air gets into the cupola for its capacity.

That the bed coke is dry and well-lighted before charging.

That the bed is of proper height to give first iron in from 8 to 10 minutes.

That the metal charges are of equal weight.

That the metal charges are no larger than that requiring coke enough just to cover the metal below.

That the coke charges are so adjusted to the metal charges that, throughout the heat, the melting zone remains stationary and at the right point.

That the blast volume (not pressure) never changes throughout the heat, since any variation will immediately change the position of the melting zone.

That the charges are evenly distributed: First, the pig iron over the entire bed, then scrap also over the entire bed, then coke. If steel is used, put it on before the pig. Never use thin scrap steel.

That only one row of tuyeres be used, and these should be of sufficient size. If a second row is available, open only a very few of them, so as not to disturb the position of the melting zone, while giving extra air to burn the CO that may form in the furnace.

That the melting rate be watched and the intermediate coke charges adjusted accordingly.

That the charging of very large pieces of metal be avoided, since these very often deflect the gas currents and bring about an uneven burning of the fuel.

Heavy coke, with small percentages of cell space, can stand large charges, anthracite coal being the extreme in this connection. Light cokes, with large percentages of cell space, must have very small charges to get best results.

## Tests of Monel Metal

Monel metal, according to recent experiments made at the laboratory of the Board of Water Supply, New York City, possesses about the same resistance to corrosive action as the better known bronzes, while in these tests it had the additional advantage that it presented the least change in appearance as a result of the corrosive action. Specimens of several bronzes, Monel metal and steel were weighed and embedded in rich earth, which was kept wet for six months by periodical additions of very dilute solutions of corrosive salts. At the end of the test period, all of the specimens were taken out, scrubbed, dried and weighed to ascertain the comparative loss from corrosion. The results in percentage of loss were as follows: Phosphor bronze, 0.09; Tobin bronze, 0.11; Monel metal, 0.12; Parsons manganese bronze, 0.12; Muntz metal, 0.33, and steel, 1.04.

## Monthly Distribution of Fixed Charges for the Year 1912

| DEPARTMENT NUMBER | INVESTMENT ACCOUNT | | | DEPRECIATION ACCOUNT | | | MAINTENANCE | | INSURANCE | | TAXES | | Power |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Valuation Based on Appraisal and Real Estate Owned | RATIO PER CENT | Monthly Charge Based on 5% Yearly on Investment | Total Depreciative Value Jan. 1, 1911 | Total Depreciative Value Dec. 31, 1911 | Monthly Charge for Depreciation | Year's Total Maintenance | Monthly Charge | Per Cent Insurable Value | Monthly Charge | % Taxable Property | Monthly Charge | |
| ONE | $22,500 | 45 | $94 | $11,250 | $10,460 | $66 | $270 | $23 | 36% | $16 | 45 | $7 | |
| TWO | 13,500 | 27 | 56 | 6,750 | 6,270 | 40 | 160 | 13 | 26% | 11 | 27 | 4 | $15 |
| THREE | 11,000 | 22 | 46 | 5,500 | 5,116 | 32 | 134 | 11 | 30% | 13 | 22 | 2 | 85 |
| FOUR | 1,900 | 3.8 | 8 | 950 | 878 | 6 | 23 | 2 | 7% | 3 | 5 | 1 | |
| FIVE | 1,100 | 2.2 | 4 | 550 | 526 | 2 | 13 | 1 | 1% | 2 | 1 | 1 | |
| TOTALS | $50,000 | 100.00 | $208 | $25,000 | $23,250 | $146 | $600 | $50 | 100% | $45 | 100 | $15 | $100 |

FIG. 1—MONTHLY SUMMARY OF COST ITEMS BY DEPARTMENTS. THE FIGURES GIVEN ARE USED MERELY FOR PURPOSES OF ILLUSTRATION AND DO NOT REPRESENT ACTUAL COSTS

# A Foundry Cost System That Produces Results

## *How a Steel Casting Plant Solved the Cost-Keeping Problem and the Economies Effected Thereby*

IN THE columns of THE FOUNDRY, frequent reference has been made to the splendid advances of the foundry industry during the past decade along mechanical lines, including especially the introduction of machine - molding, mechanical sand-handling equipment, compressed air, electric hoisting apparatus and other labor-saving devices. While at the same time progress has been made toward better business methods and more efficient systems of organization, it has been slow compared with the swift strides in purely operating problems. Gradually, however, foundrymen are coming to realize that a well-equipped shop is only half the battle and that correct business principles are equally important. Consequently there is a growing interest in cost keeping, since business, if it be done at all, must be executed at a profit, and work turned out at a loss is worse than none.

One reason why the foundry trade, referring especially to the jobbing shops, has been slow to take up this question of cost keeping has been due to the difficulty in working out systems that are efficient, accurate and also inexpensive. The few shops fortunate enough to have good cost systems have jealously guarded the details, with the result that many plants are working in the dark, often bidding absurdly low and preventing the whole industry from being conducted on a profitable plane.

### *Crucible Steel Casting Cost System*

In the September, 1912, issue of THE FOUNDRY, in an article discussing the "Crucible Process for Making Steel Castings," brief mention was made of a cost system used by the Sivyer Steel Casting Co., of Milwaukee. This system has a number of good points, chief among which are its simplicity, economy and accuracy. It is the purpose of this article to describe the system more at length.

It should be stated at the outset that the figures given in the accompanying forms are introduced simply for the purposes of illustration. They are purely arbitrary and while an attempt has been made to use reasonable values and preserve correct proportions, the figures do not represent actual costs, either in the shop under discussion or in any other plant.

Referring again to the article in the September issue, it was stated that, "The cost of castings is estimated on a basis of material and molding labor according to the following formula:"

$$\text{Cost per pound} = \frac{WP + L + FL}{w},$$

where $W$ is the total weight of metal required for the casting.

$P$ is the price of the metal per pound.

$L$ is the cost of molding labor for the casting.

$F$ is a factor which expresses all other expenses in terms of molding labor.

$w$ is the weight of the finished casting.

The factor $F$ is obtained from the monthly cost sheet and includes the following items, each expressed as a per cent of molding labor:

$F = N + M + I + C + O$ where

$N$ is the non-productive molding department labor.

$M$ is miscellaneous expense in the molding department.

$I$ is fixed expense in the molding department.

$C$ is cleaning department expense.

$O$ is core department expense.

In applying this formula the cost record must be depended upon to furnish the price of the metal per pound, $P$, the cost of molding labor for the casting, $L$, and the factor, $F$, the latter being especially important since it involves a number of elements. The records necessary to supply this information are kept on three simple forms, which are illustrated herewith.

Once a year the monthly distribution of fixed, overhead charges is made out by departments according to the form shown in Fig. 2. Every month a summary of the detailed costs of each department is computed in the form shown in Fig. 1. From this sheet the correct values for the unknown quantities in the cost formula are obtained; also a series of these sheets covering a period of a year or more provides opportunity for exceptionally valuable comparisons. A daily record of the principal cost and financial items, concerning which information is desired, is kept as indicated in Fig. 3.

The first step in the practical application of this cost system consists in determining the fixed charges shown in Fig. 2. The fixed charges include interest on investment, depreciation, maintenance, insurance and taxes. For each of these items a monthly charge, showing the burden carried by each separate department, is computed. Take, for instance, the investment account. The total valuation of the plant based on an appraisal and cost of real estate is assumed at $50,000. For the purpose of cost keeping, the plant is divided into five departments, namely, melting, molding, cleaning core and office. The proportion of the total investment of $50,000 chargeable to each department is indicated in Fig. 2, and a monthly charge based on 5 per cent interest on the investment in each department is calculated. The investment in department 1, melting, being $22,500, the interest on this sum at 5 per cent is $1,125 per year, or $94 per month approximately. In a similar manner the monthly investment charge for department 2, molding, is found to be $56, for department 3, cleaning, $46, for department 4, cores, $8, and for department 5, office, $4, or a total of $208 per month, equivalent to 5 per cent interest on the aggregate investment of $50,000.

### *Computing Monthly Depreciation*

The amount chargeable to each department monthly for depreciation is computed in a slightly different manner. As indicated in Fig. 2, there are two columns under *Depreciation Account,* which show the total depreciative value of the investment in each department at the beginning of the year and again at the end of the year. The difference between these two quantities in each case is the total depreciation. This amount divided by 12, of course, gives the monthly depreciation charge directly. For instance in department 1, the total depreciative value at the beginning of the year was $11,250 and at the end $10,460, the difference being $790 or $66 a month. The depreciative value of the entire plant at the beginning of the year is assumed at $25,000, or one-half the total investment. While these figures are purely arbitrary, in an actual case the depreciative value never equals the amount invested, since there is considerable property, such as real estate, which does not frequently depreciate, and which in certain cases may even appreciate. When

## Distribution of Costs for One Month

| DEPT. 1 MELTING | Expense Labor | Miscellaneous Expense | | Total Exp. | Material Used | | Total Cost Dept. 1. |
|---|---|---|---|---|---|---|---|
| | | Investment | $94 | | | | Castings shipped 100,000 pounds |
| | | Depreciation | 66 | | | | |
| | | Maintenance | 23 | | | | |
| | | Insurance | 30 | | | | |
| Office | $50 | Taxes | 15 | | Punchings | $1600 | Cost per ton, $82 |
| | | Crucibles | 1300 | | | | Cost per lb. $.041 |
| | | Oil | 730 | | Risers | 100 | |
| | | Brick | 10 | | | | |
| | | Manganese | 14 | | | | Material melted, 4% loss, 240,000 lbs. |
| Payroll | 200 | Silicon | 12 | | | | |
| | | Aluminum | 17 | | | | |
| | | Vanadium | 9 | | | | Cost per ton at edge of furnace, $34 |
| | | Misc. Expense | 21 | | | | |
| | | Office Expense | 54 | | | | |
| | | Sub. Total | $2395 | | | | Cost per pound at edge of furnace, $.017 |
| | | Credit Scrap | 100 | | | | |
| | | Credit Crucibles | 145 | | | | |
| Totals | $250 | | $2150 | $2400 | | $1700 | $4100 |

| DEPT. 3 CLEANING | Expense Labor | Miscellaneous Expense | | Total Cost in Dept. 3 |
|---|---|---|---|---|
| | | Investment | $46 | |
| | | Depreciation | 32 | Castings shipped 100,000 pounds |
| | | Maintenance | 11 | |
| | | Insurance | 25 | |
| | | Taxes | 5 | |
| | | Office | 245 | Cost per ton $35 |
| Payroll | $900 | Power | 100 | |
| | | Sand | 66 | Cost per pound $.0175 |
| | | Hack saw blades | 27 | |
| | | Barrels & bags | 20 | |
| Office | 225 | Miscellaneous | 53 | |
| Totals | $1125 | | $630 | $1755 |

| DEPT. 2 MOLDING | Productive Labor | Expense Labor | Per Cent P. L. | Miscellaneous Expense | | Amount | Per Cent P. L. | Total Cost Dept. 2 |
|---|---|---|---|---|---|---|---|---|
| | | | | Investment | $56 | | | Castings Shipped 100,000 Pounds |
| | | | | Depreciation | 40 | | | |
| | | | | Maintenance | 13 | | | |
| Payroll | $1200 | $500 | | Insurance | 29 | | | Cost per ton, $56 |
| | | | | Taxes | 12 | | | Cost per lb. $.028 |
| | | | | Office | 325 | | | |
| | | | | Power | 26 | | | Cost of productive labor per pound (average) $.012 |
| | | | | Sand | 180 | | | |
| Office | | 300 | | Clay | 96 | | | |
| | | | | Lumber | 10 | | | |
| | | | | Nails | 4 | | | |
| | | | | Miscellaneous | 9 | | | |
| Totals | $1200 | $800 | 66.7 | | $800 | $1600 | 133 | $2800 |
| RECAPIT-ULATION | | | | | | | | Total Cost Whole Plant |
| Molding | $1200 | $800 | 66.7 | | $800 | $1600 | 133 | $2800 |
| Cleaning | | 1125 | 94.0 | | 630 | 1755 | 146 | 1755 |
| Cores | | 125 | 10.3 | | 80 | 205 | 17 | 205 |
| Totals | $ 200 | $2050 | 171.0 | | $1510 | $3560 | 296 | $4760 |
| | | | | | | | | 4100, Cost Dept. 1 |
| Whole Plant | $1200 | $2050 | 171.0 | | $1510 | $4760 | | $8860 |

| DEPT. 4 CORES | Expense Labor | Miscellaneous Expense | | Total Cost in Dept. 4 |
|---|---|---|---|---|
| | | Investment | $8 | |
| Office | $25 | Depreciation | 6 | |
| | | Maintenance | 2 | Castings shipped 100,000 lbs. |
| Payroll | 100 | Insurance | 5 | |
| | | Taxes | 3 | |
| | | Office | 26 | Cost per ton $4 |
| | | Coke | 12 | Cost per lb. $.002 |
| | | Sand | 8 | |
| | | Miscellaneous | 10 | |
| Totals | $125 | | $80 | $205 |

| DEPT 5 OFFICE | Expense Labor | Miscellaneous Expense | | Total Cost in Dept. 5 |
|---|---|---|---|---|
| | | Investment | $4 | |
| | | Depreciation | 2 | |
| | | Maintenance | 1 | |
| | | Insurance | 2 | |
| | | Taxes | 1 | |
| | | Interest | 60 | |
| Salaries | $600 | Teaming | 220 | |
| | | Express | 50 | |
| | | Miscellaneous | 50 | |
| | | Discounts | 60 | |
| | | Selling exp. | 125 | |
| | | Contract labor | 100 | |
| | | Sub Total | $675 | |
| | | Credit discount earned | 25 | |
| Totals | $600 | | $650 | $1250 |

**The charges for salaries and miscellaneous expense in the office department are distributed among the other four departments in the ratio of their payrolls.**

FIG. 2—DISTRIBUTION OF FIXED CHARGES BY DEPARTMENTS. THE FIGURES GIVEN ARE USED MERELY FOR PURPOSES OF ILLUSTRATION AND DO NOT REPRESENT ACTUAL COSTS

the various sums for depreciation have been computed in the manner described, they may then be reduced to a percentage basis if desired.

Maintenance includes such extraordinary repairs and replacements as cannot be properly charged to depreciation, and which are always too large to be charged to operating expenses. The total of such charges for each department for the year is given in Fig. 2 under *Maintenance*, and these items divided by 12 give the proper monthly charges. In a similar manner the insurance and tax items are figured out, using the proper per cent of insurable value and taxable property in each case as a basis.

These various calculations give a series of monthly charges, which may be transferred directly to the distribution sheet, showing the detailed costs in each department.

A monthly summary, showing the costs in each of the five departments, is made out according to the form given in Fig. 1. From this summary the correct value for the factor *F* in the cost formula is obtained. The greatest simplicity coupled with accuracy has been aimed at in making up these sheets. The expenses in each department are divided into a number of general groups, such as labor, material and miscellaneous expense. The proper items for interest on investment, depreciation, maintenance, insurance and taxes are entered under a general head of miscellaneous expense in each case.

*Division in Melting Department*

Taking for instance the melting department, the monthly charge for investment, as shown in Fig. 2, is $94 and for depreciation and maintenance $66 and $23, respectively. These items are set down against *Investment, Depreciation* and *Maintenance* under the general *Miscellaneous Expense* in that portion of Fig. 1 devoted to melting department costs. In a similar manner the monthly fixed charges for the other departments, as given in Fig. 2, are transferred to the distribution sheet, Fig. 1. It will be noticed that the items charged to insurance and taxes in Fig. 1 do not correspond with the monthly charges for insurance and taxes for the various departments as given in Fig. 2. This is because an amount covering liability insurance, state income and federal corporation taxes from month to month is added to the fixed portions of these items when they are entered in Fig. 1.

*Office Expense*

There is no factor in the cost formula for office expense. This item, which amounted to $1,250 in the example under discussion, is included in the costs charged to the other four departments. The sub-division is based on the ratio of the payrolls in the various producing departments. The total office expense, $1,250, consists of salaries, $600, and miscellaneous expense, $650, as indicated in Fig. 1. The payrolls in each of the other four departments, melting, molding, cleaning and core, are $200, 1,200, $900 and $100, respectively, the total being $2,400. The payroll in the melting department, $200, is therefore, 8 1/3 per cent of the total payroll of $2,400. Hence 8 1/3 per cent of the $1,250 office expense is charged to *Office* in the cost of operating department. For convenience this amount is divided into its two elements, salaries and miscellaneous expense, the salary item, amounting to $50, this being 8 1/3 per cent of $600, and the miscellaneous expense item amounting to $54, which is 8 1/3 per cent of $650. In this way the office expense is divided equitably among the four productive departments.

The detailed expenses of department 1, melting, are grouped under three headings, namely *Expense Labor, Miscellaneous Expense and Material Used.* Space is also provided on the cost sheet for the *Total Cost* as indicated in Fig. 1. The heading *Expense Labor* includes $50 office labor charged to department 1, as explained above, and the $200 payroll. The latter covers the wages of the melters and their assistants, the total charged to *Expense Labor* being $250. Under *Miscellaneous Expense* are grouped the five items covering fixed charges, namely investment, depreciation, maintenance, insurance and taxes. The method of entering the proper amounts against these items has been explained. *Miscellaneous Expense* also includes the amount paid out for crucibles, oil, brick, manganese, silicon, etc. Since the melting department payroll is 8 1/3 per cent of the total payroll, $54 of the $650, miscellaneous office expense is also charged with the foregoing items. The melting department is credited under *Miscellaneous Expense* with the scrap and crucibles sold, the net sum chargeable to the department being $2,150.

DAILY SUMMARY FOR ONE MONTH

| WORKING DAY | DATE | SALES | TONNAGE | BANK BALANCE | ACCOUNTS RECEIVABLE | ACCOUNTS PAYABLE | CASTINGS SCRAPPED | FURNACE SCRAP | FLOOR SCRAP | GATES AND RISERS | LABOR | | | | | | NO. OF FURNACES RUNNING | NO. OF HEATS | NO. OF POTS | PUNCHINGS USED | SCRAP USED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | MOLDING | CLEANING | CORE | FURNACE | OFFICE | TOTAL | | | | | |
| | | $ | S. | $ | $ | $ | LBS. | LBS. | LBS. | LBS. | NUMBER OF MEN | | | | | | | | | LBS. | LBS. |
| 1 | 1 | | | | | | | | | | | | | | | | | | | | |
| 2 | 3 | | | | | | | | | | | | | | | | | | | | |
| 3 | 4 | | | | | | | | | | | | | | | | | | | | |

FIG. 3—DAILY SUMMARY OF COST ITEMS

In this case it is also assumed that the material used during the month cost $1,700, making the total charged to department 1, $4,100. It is also assumed that 100,000 pounds of castings are shipped. The cost per ton is therefore $82 and the cost per pound is $0.041. The cost per ton at the edge of the furnace, that is the cost based on material melted instead of on castings shipped, is $34 per ton. This figure is obtained by dividing the total cost, $4,100, by the amount of material melted, 120 tons.

*Department Two*

The costs in department 2 are grouped under three headings, *Productive Labor, Expense Labor* and *Miscellaneous Expense,* also the ratio of the two latter items to the expense for productive labor is computed. The expense labor being $800 and the productive labor $1,200, the former is clearly seen to be 66.7 per cent of the latter; the sum of the expense

labor and the miscellaneous expense is $1,600, or 133 per cent of the productive labor. Since we have assumed that 50 tons of castings are shipped, the melting cost per ton works out $56. The total cost for productive labor for the month under consideration being $1,200, the average cost per pound is calculated to be 1.2 cents. The various ratios to productive labor are very important, since they are used in computing the factor $F$ appearing in the estimating formula.

From the foregoing explanation, it is clearly evident how the expenses in the three remaining departments, cleaning, cores and office, are calculated. In each of these cases the expenses are grouped under two prinpal heads, *Expense Labor* and *Miscellaneous.*

*Recapitulation*

After the detailed expenses of each department have been worked out and the office expense properly proportioned among the other departments, the various totals are recapitulated, as indicated in the lower left hand corner of Fig. 1, and the ratio of all the other expenses to the cost of productive labor in the molding department is calculated. Using the figures which we have assumed, this ratio is 296 per cent. The recapitulation, of course, does not include the melting department expenses, since the latter are dealt with separately in the estimating formula. As previously stated, this formula is as follows:

$$\text{Cost per pound} = \frac{WP + L + FL}{w}$$

The price of the metal per pound, represented by $P$ in the formula, is obtained from Fig. 1, under "Melting Department Expense," where it is given as $0.017 per pound. Fig. 1 also gives the average cost of productive labor in the molding department as 1.2 cents per pound, and this may be used in computing the term $L$ in the formula for any ordinary casting. In order, however, to have more specific information on this important matter, separate records are kept giving the molding time, and, therefore, the molding cost of each job, with which new work may be compared. This is a more satisfactory method, since the average figure has only a limited application and is liable to lead to erroneous results if not properly applied. The individual records of molding time indicate that the molding cost varies from $5 to $50 a ton. The factor $F$ in the formula is obtained direct from the *Recapitulation* in Fig. 1, and in this case is 296.

The application of the formula in connection with the cost quantities given in Fig. 1 may best be explained by an example. Assume for instance a connecting rod weighing 50 pounds. Assume also that the weight of the heads and risers is equal to 20 pounds, so that the total weight of the rough casting is 70 pounds. The cost of the casting is as follows:

$$\frac{WP + L + LF}{w} =$$

$$\frac{(70 \times 1.7) + (50 \times 1.2) + (60 \times 2.96)}{50}$$

$= 7.15$ cents per pound.

No cost system is absolutely accurate, and the efficient system is the one which gives the most accurate results at the least expense. It is thought that the system described herein is specially noteworthy for its accuracy combined with economy. This is an important characteristic, since a cost system which does not tell the truth is worse than none. In fact, it is probable that more managers are led astray by false statements found in their cost records than get into trouble through the lack of any system at all. Of course the human element enters into this phase of the question, it requiring no little amount of moral courage to face the actual figures when things are going badly. It is very easy in such cases to juggle the cost items a little so that they will give a favorable appearance, but this is encouraging a practice of self-deception that is very dangerous.

## Steel Roll Difficulties

*Question*: — We have considerable trouble with the steel rolls which we are making, as ragged holes develop in the necks after machining. These do not appear to be shrink-holes and we are unable to account for this difficulty. We also experience trouble from the sand burning into the wabblers and small cores that support large bodies of metal.

*Answer*:—It seems somewhat difficult to determine the cause of your trouble without having an opportunity to inspect the castings. The ragged holes referred to may be shrink-holes. However, this could be determined best by an examination of the holes themselves. Ordinarily, a shrink-hole is rather ragged, and is unlike a blow-hole. Castings of heavy sections, such as rolls, require liberal risers or sink-heads, but some foundrymen make the mistake of providing such risers with necks of too constricted an area, thereby producing an early solidification of the neck of the riser and the consequent inability of the sink-head to perform its function. To reduce the wastage in the riser itself, and at the same time to permit of properly feeding the casting, some foundrymen resort to the use of stirring rods and charcoal thrown on top of the riser. Others introduce a small can of thermit into the riser just before it freezes. This is generally found to be the better plan, since the use of thermit will not produce hard spots, such as are occasionally found as a result of the use of charcoal. The hard spots, due to charcoal, are produced by the absorption of carbon.

On the other hand, the cavities might be the result of an inadequate radius and a pronounced lack of uniformity of section. If this is the case, the difficulty can probably be overcome by allowing a much more liberal fillet, which will serve to graduate the sections. If an ample fillet is provided and the location and area of the risers are carefully calculated, the chances are that the difficulties experienced will be overcome. If the ragged holes referred to should prove to be blow-holes—which is not probable—the careful use of proper deoxidizers, such as manganese, silicon and aluminum, and the thorough drying of the mold should, of course, solve the problem. Sufficient vents, however, should be provided for the escape of the gas generated when the metal enters the mold.

With reference to the sand burning into the wabblers and the trouble experienced with small cores, this can be remedied by careful attention to the sand which would have the requisite bond with a minimum amount of non-refractory material. However, it is exceedingly difficult to surround a small core with a large mass of steel without the liability of having the steel burn into the core. It is a good plan to make such a core with a very close, dense surface. Equal parts of silica sand and silica flour occasionally are used in such core mixtures with good results. Subsequent washing of the core with plumbago or with a silica wash will help materially.

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Announcement has been made by the Mumford Molding Machine Co., New York City, that notwithstanding the fact that its product and sales are controlled by the Vulcan Engineering Sales Co., Fisher building, Chicago, its identity as an independent corporation has been retained, similar to that of the Q. M. S. Co. and the Hanna Engineering Works, which likewise are represented by the Vulcan Engineering Sales Co., as sales agent.

# Making Patterns for Machine-Molded Gears--I

***The Successful Employment of the Gear-Molding Machine is Dependent Largely Upon the Accuracy of the Patterns Used***

By Joseph Horner

CAST gears are still extensively employed in the construction of machinery, notwithstanding the growing use of cut gears. Complete patterns for molding, to a large extent, have been replaced by sectional patterns of gear wheels, containing one or more teeth, which form the essential operating part of gear-molding machines. The latter practice is to be preferred to the use of the complete pattern, not only on account of the accuracy it insures, but the economies effected as well. When complete gear wheel patterns have become worn, it is difficult to obtain accurate molds and each size of gear requires a different pattern. On the other hand, the gear molding machine is exceedingly flexible as it permits of making gears with any number of teeth and variety of pitch, in different diameters up to its capacity, by the use of the sectional wheel patterns which can be adjusted readily. While the arms are not machine-molded, they are easily made with cores.

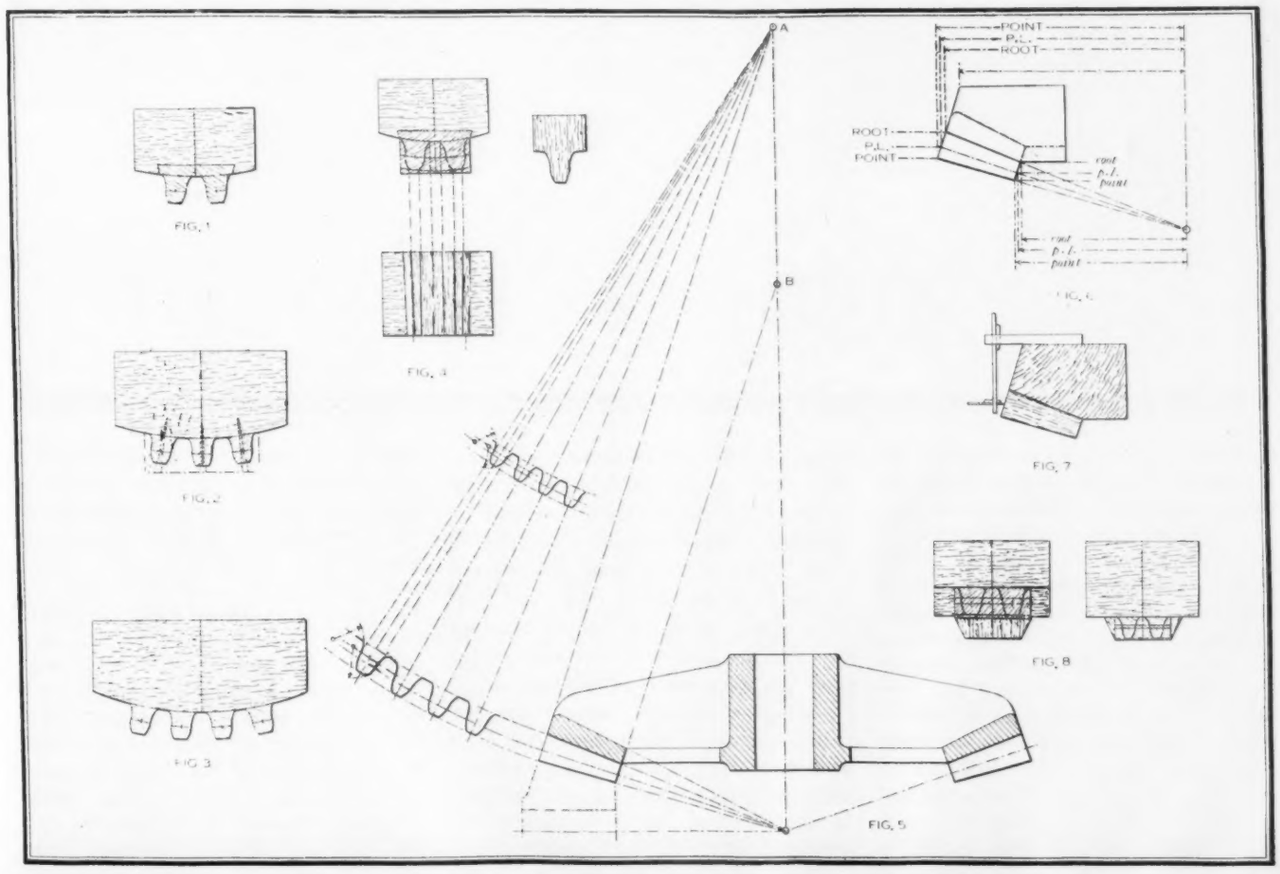
### *Gear Molding Machines*

All gear molding machines are dividing tools employing change gears, by combinations of which the pitching is effected. The stem of the machine is provided with a carrier to which the tooth-block or pattern is attached, and the withdrawal of the pattern from the mold is effected by turning a hand wheel. After each withdrawal of the pattern from the mold the main arm is carried around to effect the pitching and the pattern is again lowered and rammed. This operation is continued until the mold is completed.

The amount of movement for pitching depends on the way in which the sectional pattern block is made. If it has two teeth, Fig. 1, the pitching is for single teeth, that is, it is equal to the pitch of the gear, because the spaces between the teeth and the tooth-points only are the parts which form the mold. But if there are three teeth, Fig. 2, the pitching or spacing is twice that of the pitch, because two tooth-spaces are rammed at each setting. If there are four teeth, Fig. 3, the pitching or spacing is three times that of the real pitch.

### *Spur and Bevel Gears*

The vertical lift of the pattern block by the machine is suitable for spurs and bevels, but not for helical gears, or worm gears when made solidly, in which case the first must be withdrawn at an angle, and the second horizontally. One or two machines are arranged to include these movements, but in most cases the vertical lift alone is provided for, and



then the tooth-block is divided into two portions, as shown in Fig. 13, and a number of subsequent illustrations. The backing is attached to the carrier of the machine, and the actual teeth with their backing are fitted with freely sliding dovetails to the rear backing. After molding, the latter is lifted first, leaving the teeth in the mold to be withdrawn by the machine or by the molder.

Laying out these tooth-blocks offers no special difficulty to the patternmaker, but some observations relating to them may be of value. The working portion of the block must

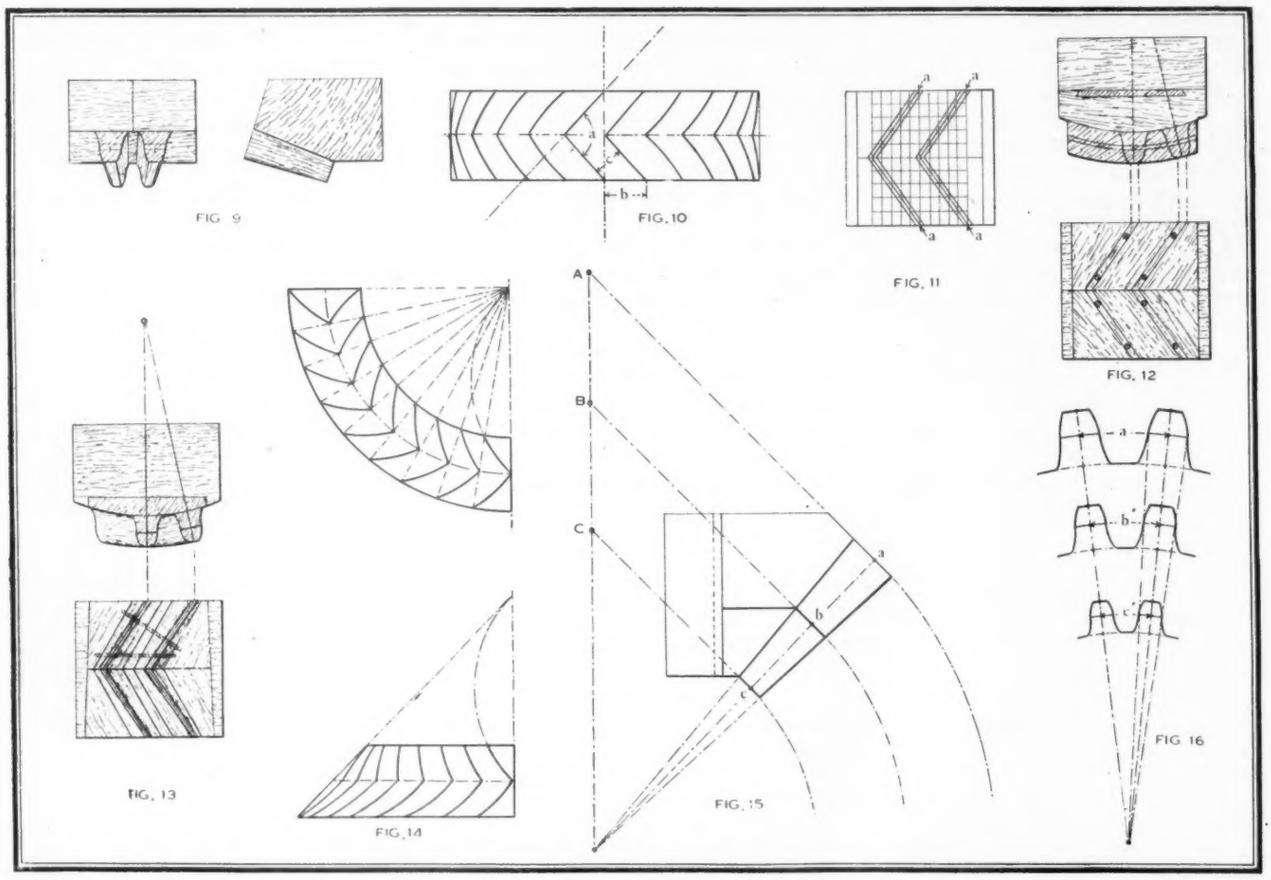
must be large enough to receive the machine carrier, and should be true and square, otherwise the teeth will be tilted out of their proper positions. The relations, therefore, of the backing to the teeth and of the teeth to the rim of the gear are essentials to be remembered when laying out the teeth.

*The Main Block*

The main block is made with the grain running horizontally. Pine will do for this part. The teeth must have the grain disposed perpendicu-

accuracy to fit the tooth portion in one piece as indicated in the dotted outlines, Fig. 2. Two fine screws are put through the center which each tooth will occupy. The teeth are cut out separately and are attached with glue and screws. Sometimes, on smaller blocks, the teeth are integral with the backing. In that case the grain runs perpendicularly and mahogany is used.

The working faces of the teeth are without draft, as indicated in Fig. 4, but the outer faces are well tapered, as shown in the same illustration. If they are not so tapered, they




be made precisely as though it were a segment cut out of the rim of the wheel, neglecting only the inner portion which corresponds with the thickness of metal in the rim. The working portion, Figs. 1, 2 and 3, includes the teeth of correct depth, with the curvature corresponding with the roots, and the top and bottom faces, although the latter are not actually produced in the mold by the block. However, the two must correspond. Neither the back face of the block nor its horizontal width are of any account as far as the mold of the casting is concerned; but these

larly and should be made of mahogany. The blocking for these teeth is fitted as one piece, sometimes let in with a dovetail and glued, as in Figs. 1 and 4. The teeth are marked in place on the pitch, point and root lines struck from the center obtained by the prolongation of the center line. By this center, the block is attached to the center line of the machine carrier. The teeth are cut with gouge, chisel and plane, or with a fly-cutter if a machine is available. In the absence of the latter tool, it is often convenient and conducive to

would be liable to crush the last tooth space rammed. The sand surrounding the square working faces would be broken unless it were held down during withdrawal by a stripping piece, shown at the right of Fig. 4. These points will be illustrated in the next article which will consider the methods of molding. Bevel gears, in several respects, are unlike spur gears. A bevel gear may be flat or steep, but in either case it is *all-taper*, and the outer faces of the teeth require no additional taper, and there is no trouble whatever with the delivery of the working faces.

Great care must be exercised to have the block of the correct bevel.

Fig. 5 shows a sketch of a flat bevel gear which has been drawn to connect the method of obtaining tooth sections and tooth shapes with the preparation of the block. The cone relations are seen in the section, and the tooth dimensions and shapes on the major diameters are obtained on the circles struck from the projected center, *A*, and those on the minor diameter from the projected center, *B*, transferred for convenience to *A*. We assume that the methods by which the tooth shapes are obtained are understood. Cycloidal teeth are shown here. Involutes are employed for helical and worm gears.

Comparing the illustrations, Figs. 6, 7, 8 and 9, with the sectional view of the casting, Fig. 5, with which they correspond, the relations between the former and latter are obvious. In Figs. 6 to 9 cardinal dimensions are transferred from the wheel section to that of the tooth block. Pitch, point and root circles are marked right and left from a center line; pitches, tooth thickness and curves are struck, as indicated, from the corresponding dimensions of the casting. No consideration has yet been given to the rim, arms, etc., but the relation of the rim thickness is indicated in Fig. 6. The various dimensions on the major and minor diameters, the former in capitals and the latter in italics, are obtained as shown in Fig. 6, the various radii first, after which the intersecting horizontal lines are struck on the ends of the teeth, using a long-toothed gage, Fig. 7; the tooth curves are marked from the projected shapes obtained in Fig. 5. The marking of the teeth in Figs. 6 and 7 is preceded by the preparation of the block to its section by the same means, the lines for which are shown in Fig. 6. The dimensions of the back and top faces of the block are of no importance except that they must be of a suitable size for the carrier and should be exactly vertical and horizontal relatively to the correct bevel of the teeth. Frequently the teeth shown in Figs. 8 and 9, are provided with a dovetail similar to Fig. 4. Fig. 8 illustrates the appearance of the back and front of the block when the teeth are marked out, and Fig. 9 is the same block after the teeth have been cut out.

Helical spur gears are more frequently molded by machine than from full patterns, except perhaps when they are of small dimensions. Briefly, it is necessary to observe that helical teeth are spiral teeth, the relation being indicated in Fig. 10. The patternmaker does not trouble about the lead of the spiral, but considers only the angle *a* included by the teeth, which varies widely in different practice, the circular pitch *b* and the normal pitch *c*. These teeth now are sloped to a much greater extent than formerly, which makes the spiral form more pronounced. It is very slight in large wheels, very obvious in pinions, and must be imparted, however slight its amount, if the teeth are to run smoothly together. To obtain it, after the approximate tooth shapes are struck on the ends, lines are drawn by bending a strip of flexible steel across the faces, or diagonals are drawn on a strip of paper which is glued around the face, thus developing the spiral. In Fig. 11 the interspaces are marked out in equal divisions as in the delineation of screws, and lines drawn through the points of division give the center lines of the teeth, *a*. This spiral shape, though scarcely perceptible in large gears, is evident in small ones, but the principle must be applied to all alike. Fig. 12 illustrates a block marked out, and Fig. 13 shows the developed pattern. In the latter illustration two templets are indicated; one is set across the teeth normally to their direction, which

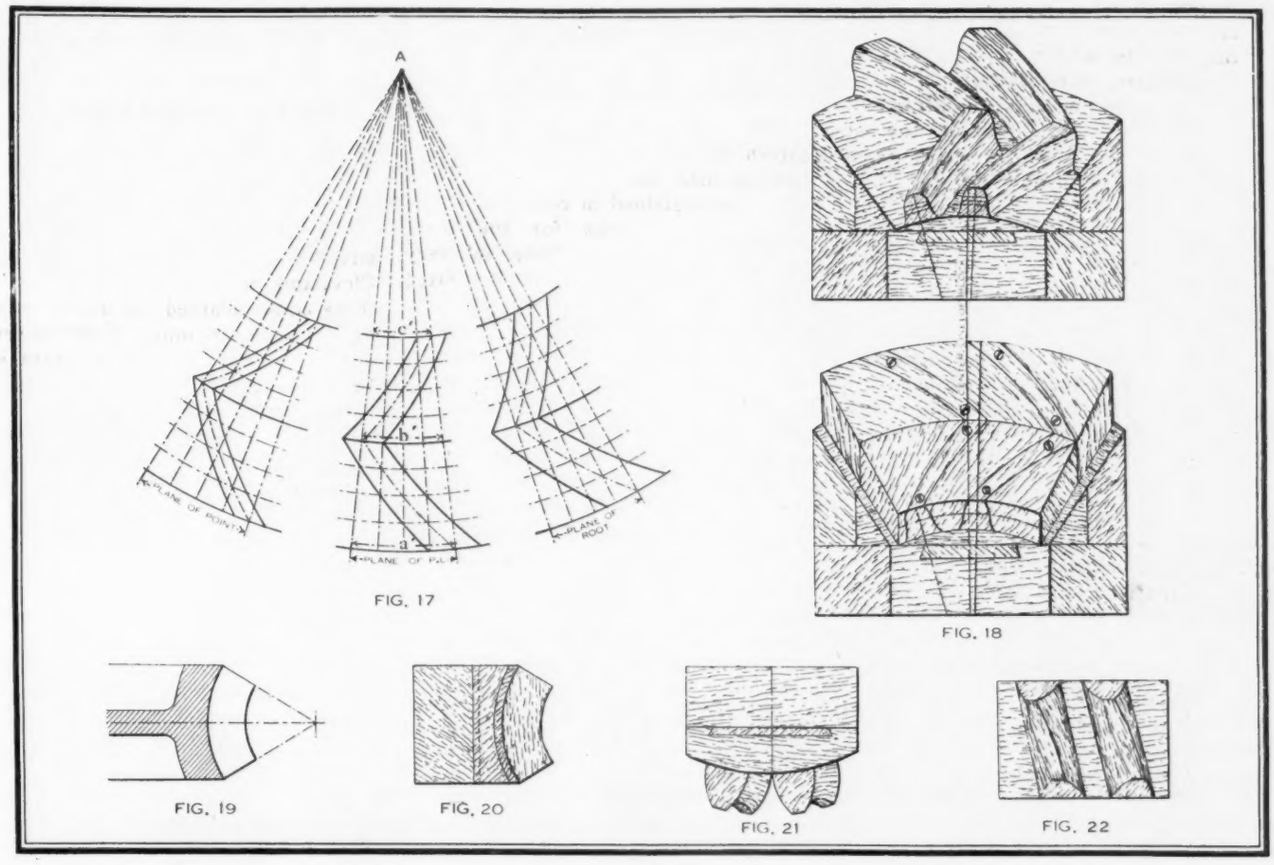



FIG. 17



FIG. 18



FIG. 19



FIG. 20



FIG. 21



FIG. 22

corresponds with the normal pitch; the other is parallel with the faces, corresponding with the circumferential pitch, indicated in Fig. 10. The latter templet gives the relations of pitch, circumference and diameter and the former the relation which corresponds with the proper tooth sections. The teeth are worked out by the first templet, guided by the lines marked on the points.

*Laying-Out Helical Gears*

In helical gears a division is made between the teeth along the middle plane, Figs. 12 and 13, corresponding with the apex, and on this plane the teeth are pitched and marked approximately, as well as on the ends. The teeth are not fastened to the backing, because it is very convenient to allow the parts to remain separated, as they can be withdrawn more readily. In addition, the division along the middle plane permits of lifting the backing vertically, leaving the actual teeth to be withdrawn horizontally. If all were made solidly, as is sometimes done, the block would have to be withdrawn in a horizontal direction. In any case, it is better that the block should be divided, since the lower half can be molded with the rammer held diagonally, without the upper half interfering with the movements of the rammer.

There are two ways in which the toothed portions are fitted to the backing. In Fig. 12 the teeth are glued to backings which are as long as the rear block, and which are attached to it with a broad dovetail. In Fig. 13 the backings are shorter and in one piece with their teeth being let in, with or without a dovetail fitting in one direction, but having the dovetailed form vertical for delivery. On the whole, the method indicated in Fig. 12 is to be preferred.

While the teeth of helical spur gears are portions of spirals developed on a cylinder, those of helical bevels are portions of right and left spirals developed on a cone, as indicated in Fig. 14. Actually, they are not laid out in this way. The cone bevels are first obtained the same as for an ordinary bevel gear shown in Fig. 5, and then the tooth length is divided into two, Figs. 14 and 15, the amount of angle included between the right and left teeth next being determined. Then the teeth are marked out on their ends and in the middle plane, and the spiral lines on the points are marked through points of equal division. The dimensions and proportions of the helical spur gears are the same on the middle plane as at the ends. The dimensions of the helical bevels are the mean of the ends, as shown in Fig. 16, which is developed from Fig. 15 on the same principle by which the pitch radii and tooth proportions of Fig. 5 are obtained. In Fig. 15 the block is outlined in section, with its jointing in relation to the section of the teeth. The plan developments, Fig. 17, giving the helical curves, are obtained by striking the major, minor and middle diameters transferred from *Aa*, *Bb*, *Cc*, respectively, Fig. 15, from one common center, *A*, in Fig. 17, and transferring the tooth centers, *a'*, *b'*, *c'*, at pitch line, point and root, respectively, from Fig. 16 to the central of the three views, Fig. 17. Then subdividing the spaces into equal parts, the helical curves are drawn through the points of division. The side views of Fig. 17, of point and root, are obtained similarly from Fig. 16.

The main block is prepared, as shown in Fig. 15, to the correct section similar to an ordinary bevel block, as explained in connection with Fig. 6. The blocks for the teeth are separate pieces. Only in very flat helical bevels can they be fitted solidly to deliver by a vertical lift. They can be molded on a machine provided with a fitting for angular adjustment of the draw which can then be made to take place normally to the bevel of the teeth. Usually, these blocks are jointed, as shown, not only for withdrawal, but because each half of the tooth length can be rammed separately much better than ramming the inner half with the outer half disposed at a different angle, blocking the use of the rammer. The upper part of Fig. 18 shows the finished block in perspective and the lower illustration is a view of this part marked out, as it appears when ready to be cut.

*Worm Wheel Pattern*

The worm wheel section, Fig. 19, is shown adjacent to the section of its block, Fig. 20. This is the only relation which can be obtained directly, excepting the tooth shapes in the middle plane which are exact involutes derived from the rack tooth section of the worm. In the teeth no section is identical along the tooth lengths. There is only one practical method of obtaining absolutely correct shapes, and that is one which imitates the hobbing method of the machine shop. The worm and tooth block are mounted as the worm and wheel would be. Two or three extra teeth are attached to the block, and the teeth are cut to fit the worm which is rotated as a templet to pass the teeth on the block, working the latter deeper and deeper as the tooth shapes are being cut, until the proper depth is reached. The supernumerary teeth are afterwards removed, leaving the two permanent ones correct for molding without marking out.

The block is divided as shown in Figs. 20, 21 and 22. The main block or backing is lifted vertically, leaving the teeth on their backing to be withdrawn in a horizontal direction. With a machine having horizontal withdrawal, the teeth can be attached permanently.

The molding of gears, the formation of the cores, etc., will be discussed in a subsequent article.

## The Use of Gas Lamps

During recent years there has been an increasing use of high-candlepower incandescent gas lamps, especially in localities where gas is obtainable at comparatively low rates. The use of these lamps, however, has been confined more particularly to stores and street lighting. The Royal Lamp Co., Cleveland, is now making a line of these lamps adapted for use in manufacturing plants, mills, foundries, etc., and in many other places where gas lamps have heretofore been considered inapplicable. Some of the features of these lamps are: Glass enamel draft, inducer and reflector, no parts to burn out and individual regulator. They are also made insect-proof and it is claimed that there is nothing on the lamps to clean except the globes. Statistics are said to show that the yearly breakage of glassware is less than one globe for 10 lamps in 100, and that with 100 lamps burning five hours per day, mantle renewals are less than one mantle per month per lamp. A 4-burner Royal lamp that develops a 500-candlepower light consumes approximately 10 feet of gas per hour. These lamps are made with or without horizontal shades, with various sizes of globes, and the standard burner tips fit any standard make of inverted mantles.

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At a recent meeting of the board of directors of the Joseph Dixon Crucible Co., Jersey City, N. J., George E. Long, treasurer, was elected vice president to succeed the late William H. Corbin. H. J. Schermerhorn, former assistant secretary and treasurer, was elected to membership on the board of directors, as well as treasurer. Albert Norris was elected assistant secretary and treasurer.

# Equipment and Management of Nickel Baths---I

By Seymour W Rowsbar

AT THE present time well-seasoned lumber suitable for plating tanks is difficult to obtain, and vats constructed of material which is not thoroughly dry are sure to prove a costly experiment. For this reason it is advisable to procure the timber in time to allow it to season thoroughly, either naturally or in a kiln, before building the tanks. Nearly all plater's supply houses furnish well-seasoned tanks at reasonable prices, but many firms desire to construct them to meet their requirements. It is a wise provision to line the nickel tanks with chemically-pure sheet lead and to burn the joints, as a soldered joint will result in dissatisfaction in a short time. Two methods are followed to protect the lead lining, either the use of matchboards or the application of a coating of asphaltum. If matchboards are used, the bottom is placed in position first and then the sides and ends and the top of the tank are filled with a strip forming a cap covering both the lining and tank material, thus preventing the accumulation of dirt between the linings and imparting a completed appearance to the tank.

*Asphaltum Lining*

The asphaltum is applied hot, either directly onto the lead or onto cheese cloth stretched over the entire surface and should be of sufficient thickness to prevent any article from coming in contact with the lead lining. Were it possible to procure absolutely sound, dry timber and to construct the tanks with perfectly tight joints, no lining would be required, but where one tank thus used is a success, 99 prove failures sooner or later and require a lining. Nickel solutions have a tendency to work through unsound spots which would resist water and then crystallization takes place in an undesirable manner.

Tanks built in the log cabin style of ¾ x 3-inch strips are very durable if well made. Short pieces of material may be used in their construction and thus the price of the heavier timber is saved. The walls of such tanks should be not less than 3 inches in thickness. The tanks should be placed on timber or trusses of suitable size to elevate them to a convenient height and to provide an air space underneath, which should be kept free of dirt and rubbish. For extra large tanks nothing excels concrete properly water-proofed and lined with asphaltum. Such tanks of course, are not portable.

Any number of rods may be used on the tanks if the articles to be plated have anodes on each side and the distance between the articles to be plated and the anode for ordinary work should not be less than 5 or 6 inches. Sheet metal, or work having no projections, and hanging directly beneath the cathode rod, may be plated in good condition at a distance of 2½ inches from the anode if the solution and current are adjusted for the purpose. Insulators used as supports for the rods are recommended, as they prevent the current from creeping through the wood framing and causing slight short-circuits which produce trouble when least expected, or the framing may be painted with two coats of acid-proofing which will resist the solution. This material may also be employed to render the entire tank acid-proof instead of the linings previously mentioned, and may be utilized for various other purposes in connection with the plating department.

Every careful plater realizes the importance of clean tank rods and connections, yet many are following the old custom of using brass tubing or rods and cleaning with pumice and a rag. Eventually this procedure reduces the size of the conductor and in the case of tubing, its thickness is soon inadequate to carry the proper current. The tubing either breaks or affords extra resistance to the current, thus producing detrimental effects upon the deposits. Such conditions develop gradually and frequently cause the plater great annoyance. To avoid these difficulties, the cathode. and anode rods may be polished and heavily nickeled and when in use only require cleaning with a wet cloth. This method is cleaner, quicker and easier than the use of brass or copper rods and the rods are not worn away or foreign substances introduced into the solution during the cleaning operation. While the connections also may be nickeled, we have found little is gained by plating, as a copper or brass connection to a nickeled rod will remain clean longer than when two brass or copper surfaces are placed together. The average plater, also desires to overhaul his connections occasionally to satisfy himself of their cleanliness. This is a very good custom, as clean connections are essential. Soldered joints are excellent when well finished, but a poorly soldered connection is worse than a joint well wrapped with copper wire and covered with insulating tape. The latter method is regarded as a makeshift and is never found in well-equipped shops.

*Temporary Connections*

When a solid rod is to be connected at right angles to another conductor and the usual tee connection is not to be obtained easily, a cheap, quick and efficient method is to split the end of the rod to be connected and to bend

each half of the split end over the conductor and to solder securely. Such a joint will remain intact for years, although subjected to vibration or acid fumes continually.

Resistance boards nearly all possess one common fault, which is a deficiency in variation of resistance. We do believe, however, that some manufacturers are becoming interested and no doubt, in the near future, a board will be developed, of exceptional range. A good rheostat or switchboard is very important and each plater has a peculiar fancy for some certain style. A base of slate equipped with german silver wire for the smaller gages and copper wire of gradually increasing thickness for the larger gages should be used. The wires should be stretched lengthwise of the slate, with the wires from each contact block terminating separately at the top of the board with a spring swivel. Each set of wires should be connected to the adjacent set by a sliding contact. This arrangement, with lever and binding posts, provides a resistance board of considerably more than the average variation and may be adjusted easily to suit different conditions. The contact pieces on the wires are moved up or down and the lever is used as with the ordinary board. For extra heavy currents, such a board is especially useful. In constructing a resistance board, german silver wire or ribbons should be used for the smaller wires, as it offers 13 times the resistance of copper wire of the same length and gage. When heated to 70 degrees Fahr., the resistance is increased to 18 times that of copper wire. Soft iron wire, which offers six times the resistance of copper, is often used to good advantage when german silver of proper size is difficult to obtain.

*Electric Measuring Instruments*

The opinion generally expressed relative to measuring instruments is that the voltmeter is an indispensable article and the ammeter a valuable accessory. Notwithstanding this opinion, our experience is to the contrary and we have met several successful platers who seldom consult the voltmeter. As the voltmeter is no guide as to the quantity of current entering the bath, it is advisable to place the ammeter in circuit between the resistance board and the tank. As it may be safely figured that one ampere will deposit 16.966 grains of nickel in one hour and the work in the bath consumes approximately 103 amperes and is allowed to run one hour, the amount of nickel deposited will amount to about ¼ pound or 412.8 amperes of current will deposit 1 pound of nickel per hour. It is also convenient to know that one ampere per square inch will deposit 0.007894 inch of nickel in one hour, or to deposit this thickness of nickel upon one square foot of surface in one hour would require a current of 9.29 amperes per square foot. If 50 amperes will deposit nickel in good condition on 25 pieces of work, the plater is confident that 150 amperes will plate 75 pieces (same article) in the same condition.

We admit that an experienced plater may determine, by inspection, whether his baths are in good order, but the best workman is not infallible and the use of measuring instruments enables the foreman to ascertain at a glance the condition of his work, thus substituting certainty for uncertainty. If a partial failure has occurred the remedial measure to be adopted may often be indicated and the current can be restored immediately to its original strength by adjusting the resistance of the circuit until the ammeter responds to its first position.

*The Solution*

When the bath has been fitted with measuring instruments and the resistance board with rods properly connected to bus bar or dynamo, the mechanical equipment may be called complete and the solution should receive attention. This is the regulation sulphate solution generally used for iron, steel, brass or copper If maintained simple and devoid of the various additions which many platers contend are necessary, it will produce splendid deposits rapidly and at very little expense for replenishing. Three-quarters of a pound of double sulphate salts of nickel is used to each gallon of water in the bath. The water should be as soft as possible and quite pure or free from organic or mineral impurities. After dissolving the salts in the water by boiling, it is allowed to cool after thorough mixing and when the anodes are suspended, it is ready for energizing. This is not absolutely essential, but if the bath is required for average, heavy nickeling, it is a beneficial procedure and may be accomplished as follows: Take a quantity of scrap nickled wire or any scrap wire and form a ball, several inches in diameter. Suspend the ball by a No. 20 copper wire from the cathode rod. If the tank is double, two or more balls will be required to hasten the operation. Open the resistance board and allow all the current possible to enter the bath in order to attack the surface coating of the anodes, and feed the solution to some extent. A few hours will suffice to prepare several hundred gallons of solution so that work may be treated quite readily. Fresh solutions and new anodes otherwise are not productive of rapid deposits for several days, but by this method the bath will be found to respond quickly and will attain the conductivity necessary for commercial purposes easily and without causing the foreman to devote his attention to the condition of the work which may receive treatment therein.

## The Origin of Shot in Cast Iron

During the discussion that ensued following the reading of a paper on "Segregation and Shot in Iron," by E. L. Rhead, before the Lancashire branch of the British Foundrymen's Association, and published on page 159 of the April issue of THE FOUNDRY, Mr. Rhead replying to a question regarding the different types of shot, stated that occasionally shot was found that was embedded and securely held in the iron of a casting, and this was due to the fact that the hot metal had dissolved the surface of the shot and had united with it perfectly. Shot of this kind were produced by splashes. Other shot that were found in castings were of a different nature, and could not be possibly produced in that manner, for the simple reason that if they were caused by splashes, their composition would be identical with that of the casting in which they were embedded. This was not the case, however, as such shot were highly phosphoric, and the reason for their being embedded, instead of rising to the upper parts of the casting, was because their specific gravity or density, was practically the same as that of the metal in which they were found. Owing to this fact, the shot remain in the position in which they are formed in the liquid metal, and are encased when the metal solidifies. The shot being high in phosphorus its melting point is lower than the metal of which the casting is composed, and the heat being retained by the massive envelope of hot metal, the shot remains liquid after the casting has solidified, and as the cavity is formed by the shot while it is in a molten and expanded condition it contracts away from the cavity as it solidifies, and may, therefore, be partially or entirely loose when cold.

A recent British patent covers the addition of small amounts of calcium and molybdenum to copper instead of aluminum and magnesium, which it is customary to use in England for the production of extra hard trolley wire.

# TROUBLES OF THE ELECTRO-PLATER

## *Discussed by Practical Men*

### Nickel-Plating Steel Tubes

*We plate large quantities of steel tubes which are closed at both ends. The tubes have two small vent holes, about* 1-16 *inch in diameter. We suspend the tubes in the bath from one end, and have experienced considerable difficulty with the nickel peeling from the lower end, especially around the holes. The solution stands 7 degrees hydrometer test and slowly turns blue litmus paper red. We use* 1½ *volts and a bath* 8 *feet long,* 26 *inches wide and* 26 *inches deep. Two rows of work will consume from* 98 *to* 110 *amperes of current. The deposit is flexible and does not break readily, although it tears easily. Short work is not affected in the same manner, although allowed the same current.*

Your trouble is evidently caused by insufficient rinsing of the tubes and it is possible that the tubes are longer than the anodes used in the bath. You do not mention the size of the tubes. However, were they but ¼ inch in diameter, a 1-16 inch vent hole would be too small for practical use while plating or cleaning for plating. Either close the holes or have them enlarged so as to enable a quick and thorough cleansing of the interior, as any foreign substance such as oil, borax or polishing compound, which may remain inside until placed in the nickel bath, will have a tendency to form a gas and if the vent is in the side of the tube, this gas escapes through the vent and contaminates the surface around the hole, causing the subsequent deposit of nickel at this spot to be non-adherent. Again, the density of your bath is too great for commercial purposes. We advise reducing the density to at least 5 degrees, or if the room is not what might be called quite warm, 4½ degrees will prove satisfactory. Nickel solutions that are too concentrated are liable to produce irregular deposits, especially during the winter months. As litmus paper is turned red, it would appear that the bath is too acid. This would affect the deposit. Neutralize a portion of the acid so that blue litmus paper is merely turned purple. This will denote only a slight acid reaction. Carbonate of nickel is the most practical neutralizing agent. You will have to make a slight allowance for the addition of metal as the carbonate not only takes up the free acid, but enriches the bath. The solution removed to reduce the density may be used to replenish other baths which may not be so rich, or it may be kept for future use. Should the tubes continue to peel on the lower end after a thorough rinsing or with the holes stopped, it would indicate that the lower portion of the bath is too heavy, and being too acid, the current, which is possibly a trifle strong, causes a rapid absorption of hydrogen and the tension between the two metals reaches the maximum point quickly with the result that the deposit is forced off in chips. Although, theoretically, the bath should be neutral in practice, it is found better to maintain it slightly acid because secondary reactions, which constantly take place during electrolysis, have a tendency to liberate ammonia and thus render it alkaline. On the other hand, excessive acidity must be avoided as it may entirely prevent the deposition of nickel upon the cathode and it is liable to cause the deposit to peel off. It would be well, also, to remember that a strong current and a weak solution alike favor the evolution of hydrogen so that you may find it necessary to slightly reduce the amount of current entering the bath after reducing the density of the solution.

### Snow-Flake Finish

*Kindly publish a method of obtaining the so-called snow-flake finish which is used on brass castings for ornamental purposes. Is the process patented?*

The snow-flake finish is said to have been originated by E. A. Bernard, a New England plater, and is a crystallized surface produced as follows: The brass casting is first buffed and cleaned and is given a film of copper in a cyanide copper bath. Only a very light deposit is permissible. Then the article is rinsed and is used as an anode in an acid copper bath. The casting should be of the yellow brass variety to obtain the best results. As soon as the cyanide copper coating is removed the crystallized surface appears and the operation is finished by washing, drying and applying a heavy-body lacquer. The surface has a tone of green which makes it very attractive. Flat or rounded portions of a casting present the crystallized effect to best advantage. A heavy copper deposit should be avoided. As far as I know, the process is not patented.

### Refinishing Steel Knives

*We have recently engaged in job plating and receive varying quantities of steel knives to refinish. We have succeeded in plating them, but it is a difficult task. Many of the knives are so badly corroded that it is practically impossible to refinish them. We will appreciate any information which will assist us in this line of work.*

Do not attempt to refinish the knives which are very badly corroded and deeply pitted, as the only way to remove the marks is by grinding and this leaves the stock too thin to answer any useful purpose. If, however, the stock is in reasonably good condition, the following is suggested: Clean them with the usual solutions of lye and soda and, if grinding is not necessary to remove pits, the knives may be stripped by using the electric current with the knives as the anode, in a solution of potassium cyanide and caustic soda, each pound to gallon of water, or the regular silver striking solution may be employed in the same manner by using care not to allow the silver removed from the knives to fall to the bottom of the tank. The first solution is preferred. Suspend the knives by soft iron wire and use sheet iron or steel as cathodes. A strong current is advised in order to hasten the operation. A tension of from 5 to 8 volts is practical, as the cyanide has no injurious effect on the steel in this case. The spongy silver which forms on the cathodes may be brushed or scraped off occasionally, to avoid impeding the current. When the

steel surface is reached, remove the knives, rinse and dry, and then cut down on a leather-covered wheel set up with No. 100 emery and run 1,600 to 2,200 revolutions per minute. Then run over a leather-covered wheel, set up with No. 150 emery and finish with flour of emery and glue on a felt wheel and place in a solution of sal-soda, 8 ounces to 1 gallon of water, until convenient to place in the potash solution for cleaning.

The cleaning should be very thorough. The articles should be left in the potash a sufficient length of time, and when removed, they should be plunged directly into a solution of 1 part sulphuric acid and 4 parts of cold water. The immersion must be accomplished quickly, followed by rinsing in cold, running water. Then place the knives in a solution of cyanide of potassium, registering at least 5 degrees Baume. Allow a moment, at least, for the dip to act, then remove and scour with pumice No. FF, slightly wet with sal-soda using a stiff bristle brush. After scouring, the knives should be passed along as rapidly as possible to the plating bath. If for any reason the subsequent operation is delayed, the knives may be permitted to remain in the cyanide solution for a short time or immersed in a sal-soda solution, as previously stated. Before plating the knives, rinse them in cold, running water and immerse in a solution of muriatic acid, 1 pint, and water, 1 gallon, to remove any film of oxide that may be on the surface and to present a chemically clean base. The temperature of the acid dip should be about the temperature of the room. This immersion is of only a few seconds duration, after which rinse quickly in clear, cold, running water and immediately, without the slightest delay, place in the striking bath. Only particular platers are today using two striking solutions, but as you have a reputation to build and sustain, I will describe both the first and the second.

*Striking Solution*

The first is composed of 1¼ pennyweight of silver chloride and 2 pounds of first quality potassium cyanide, to 1 gallon of water, using an anode surface of both silver and copper in proportions of 4 of pure copper to 1 of silver, and a voltage of 1½ to 2 volts. Agitate the work during the striking operation and remove when a yellow coating of silver is obtained. Then place immediately in a second striking solution, consisting of ½ ounce of silver chloride and 8 ounces of potassium cyanide to 1 gallon of water. Permit the work to remain in this solution until thoroughly coated, which will require a few minutes. Keep the work agitated during the operation. The work is now ready for the regular silver solution consisting of 3 ounces of silver chloride and 6 ounces of potassium cyanide to 1 gallon of water. This bath must be equipped with abundant anode surface of pure silver anodes, arranged on both sides of the work, and a tension of 1 volt will be sufficient, as anything in excess of this pressure is liable to cause burned edges. Agitate the work during plating. A deposit obtained in from 1½ to 2 hours should prove a very durable coating. If you desire a really excellent finish, scratch-brush lightly and burnish. Then go over the work with a soft buff to remove burnishing marks, or the burnishing may be dispensed with and the knives simply buffed with soft rouge. The operation of scratch-brushing should be carried out, as it serves to harden the deposit. Wash and pass through clean hot water and dry in boxwood sawdust.

## Electric Cleaning Solution

*We have never used an electric cleaning solution, but now desire to try this method of preparing work for plating. We are informed that cyanide of soda acts splendidly in a solution. We would like to obtain a formula for a solution which saponifies the grease removed from the work.*

An electric cleaning solution containing cyanide is generally conceded to be the best, but, owing to the fact that the poisonous spray which is always arising from such a solution proves very injurious to the health of the operator, the solution is not used except where the plant is equipped with a strong exhaust fan with hoods over the tank to minimize the danger. Comparatively few platers today are using it. A solution consisting of equal parts of caustic soda or caustic potash and sal-soda is used very extensively. Some platers add to this a small amount of rosin, about 2 pounds to 150 gallons of solution. A solution of equal parts of sal-soda and mineral cleaner also gives excellent results. Mineral cleaner is the trade name for a preparation now on the market. In preparing a cleaning solution, due consideration should be given to the character of the material to be removed from the work. If a polishing paste is used which contains mineral oil, then no electric cleaning solution will saponify it. If, however, tallow from mutton or beef is used, a simple caustic will answer the purpose.

The annoyance caused by unsaponified grease may be greatly lessened by either of the following methods: The work may be given a preliminary wash in potash before entering the electric cleaning solution, or the tank containing the cleaning solution may be fitted with two compartments in so-far as the surface of the solution is concerned, by placing a partition across the tank, which extends only an inch or so beneath the surface. One compartment is made at least two-thirds the length of the tank and is used for cleaning. The work is suspended as the cathode and the smaller portion is used for the removal of the work, the latter having been passed beneath the partition by means of hooks. In this manner the surface of the solution in the smaller space is kept clean and the removal of work is effected without contaminating the surface of the solution. The solution in the larger space must be skimmed frequently, to be kept in good condition, and the solution replenished with the cleaning material at regular intervals. This method is in use in one of the largest plants in the east, supervised by a world-renowned inventor, and is said to be the best of many heretofore tried. The caustic soda and sal-soda solution should be used hot, at 12 to 15 degrees Baume. From eight to 12 volts are required for some work, while many are using the cleaner with only three or four volts, but this makes slow work. The articles to be cleaned are used as the cathode and the tank or a sheet of iron used as the anode. Keep the solution clean by frequently siphoning off the clear solution and removing the dirt from the bottom. For work which is to receive nickel or silver direct, a swabbing operation should be performed after removal from the cleaner. Many platers use no pumice or whiting, simply swabbing with a cotton swab and rinsing. A cyanide copper strike, used hot, also may be used to advantage, especially if kept strong in cyanide and with the minimum amount of carbonate of copper.

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The Henry S. Wyckoff Co., manufacturer of platers' supplies, is now located in its new plant at 60 Arlington street, Newark, N. J. The company is an outgrowth of the jobbing business of H. S. Wyckoff, formerly at 78 Barclay street, New York City. Thomas J. Dowling, formerly with the Zucker, Levett & Loeb Co., is associated with Mr. Wyckoff.

# Use of Compressed Air in Foundry Practice*

## *The Advantages of Air Operated Hoists and Tools in Casting Shops and the Economies They Effect*

By Arthur F Murray

TO SAY that no foundry should be without an adequate supply of compressed air is almost as trite as to say that no steam power plant should be without steam. But in spite of the many advantages that the user of pneumatic appliances has over the foundryman who is without them, many foundries throughout the country are without any supply of compressed air and a larger number make less use of it than they should.

It is not the purpose of this paper to present a scientific treatise on compressed air or a mass of figures as to costs of operation and resultant savings. These are so dependent on individual conditions that figures drawn from general statements would be of little value. I shall merely attempt to outline the uses to which compressed air is put by the wide-awake foundryman.

It may be well to list the more important uses for compressed air in the foundry, starting with the handling and mixing of materials and proceeding through the core and molding shops to the cleaning room and shipping floor.

Applications of compressed air:

*Handling Materials*

Air hoists.
Pneumatic elevators.
Pneumatic cupola charging machines.
Fuel oil systems.

*Core Shop*

Core carriage hauling devices.
Core sand preparation (pneumatic riddles).
Coremaking machines, jolt ram type.
Coremaking machines, roll over type.

*Molding Floor.*

Molding machines:
Plain jolt or jarring type.
Combination jarring and squeezing types.
Combination jolt ram and pattern drawing types.
Plain vibrator types, power squeeze types.
Power squeeze, power-draft types.
Power squeeze, power roll-over, power-draft types.
Power sucker types with vibrator.
Pneumatic rammers.
Pneumatic molding sand sifters or riddles.
Blow guns.
Spraying devices.

*Cleaning Room*

Pneumatic chippers.
Sand blasts, high or low pressure.
Sand blast tumbling barrels.

The air elevator is used frequently in place of the hydraulic elevator for sand pits or other places where the hydraulic elevator would require the installation of long lines of large piping, expensive pump installations and trouble from freezing. It is simple, cheap and effective, although not to be recommended for the continuous service of the cupola stage. Where the lift is long, indirect air elevators, similar to the indirect hydraulic elevators used in office buildings are frequently employed.

A great many foundries use fuel oil for skin drying, melting furnaces, core ovens, etc. The air displacement system is a simple means of transporting this from the place of storage to the place of use. In this system air is not applied directly to the storage tanks but alternately to two small pressure tanks which receive their supply of oil

*Presented at the Buffalo meeting of the American Foundrymen's Association.

FIG. 1—COMPRESSED AIR MOTOR HOISTS WHICH SERVE THE MOLDING FLOOR IN THE PRATT & WHITNEY CO.'S FOUNDRY, HARTFORD, CONN.

FIG. 2—ANOTHER VIEW OF THE MOT OR HOIST INSTALLATION SHOWN IN FIG. 1

by gravity from the main storage tanks. Simple cross-over valves are used and are changed over once or twice a day, usually by hand, but sometimes automatically.

*Compressed Air in the Core Room*

The core room is often a neglected part of an otherwise up-to-date plant. Therefore, opportunities for savings are usually good. If core costs can be sufficiently reduced, the entire molding practice may be radically changed, coring taking the place of difficult pockets, loose part work or multiple part flasks. Jolt machines for making cores are meeting with increasing favor. For success on core jolt machines, boxes must be substantially built or they will be knocked to pieces. But the cost of a well-built core box is little more than that of a poorly built one, and the use of core jolt machines will reduce most core costs 25 to 50 per cent.

One of the most remarkable changes in foundry practice during the past five years has been caused by the general adoption of the jarring machine, jolt-rammer, bumper, or bouncer, as it is variously termed by makers and users. No other single type of molding machine is applicable to as wide a range of work, or requires as little special pattern and flask work.

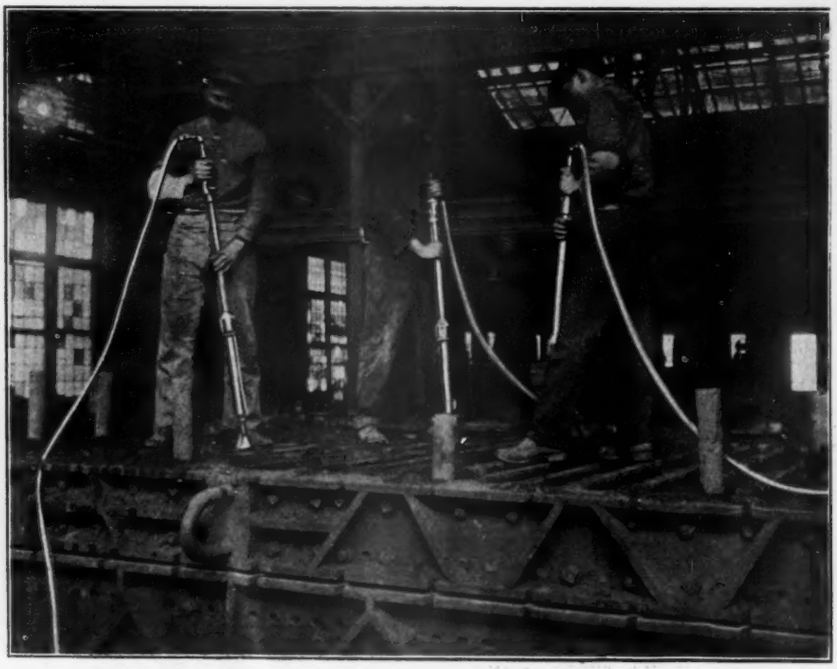

FIG. 3—THE USE OF PNEUMATIC SAND RAMMERS FOR MAKING LARGE MOLDS

One of the most essential requirements for the profitable operation of jarring machines is efficient crane service. Nothing will show up the crane service like the presence of a good sized jarring machine on the molding floor. Inefficient crane service in a hand-molding foundry of course means idle time for the molder, but he will usually not make much of a row about that. When the jarring machine comes in, the foreman and manager are watching it and delays caused by the crane are quickly noted. In properly operating the jarring machine, molds are set up on the floor, clamped, picked up by the crane, carried to the machine and rammed, picked up again and turned

FIG. 4—THE PNEUMATIC SAND RAMMER FOR BENCH WORK

over, and then carried to the finishing floor by the crane. In connection with the jar-ramming machine in our foundry, I have found it profitable to install 5-ton independent high-speed auxiliary hoists on each of the two 60-foot traveling cranes, as well as in a 2-ton electric jib crane and an 8-inch air hoist.

The jarring machine, though covering a wide range of work, is not a universal panacea for high costs and poor castings. For specialty work the plain hand squeezer with vibrator attachment is widely used. For this same class of work the ramming is sometimes done by hand or on a plain squeezer, and the pattern drawn by a sucker with vibrator attachment.

The very fact that there are so many types of air-operated molding

machines only emphasizes the previous statement that air is to the foundry what steam is to the power plant.

The subject of sand-blasting is so broad that it can only be treated adequately in a separate paper. However, compressed air is used extensively for cleaning castings. For cleaning small castings that are not fragile the sand blast tumbling barrel renders excellent service. There are a number of machines built on the principle of a rotating barrel with one or both heads stationary. A nozzle or nozzles from a regular sand blast machine is inserted through openings in these heads. Most of these machines operate on the low pressure system. Some return the

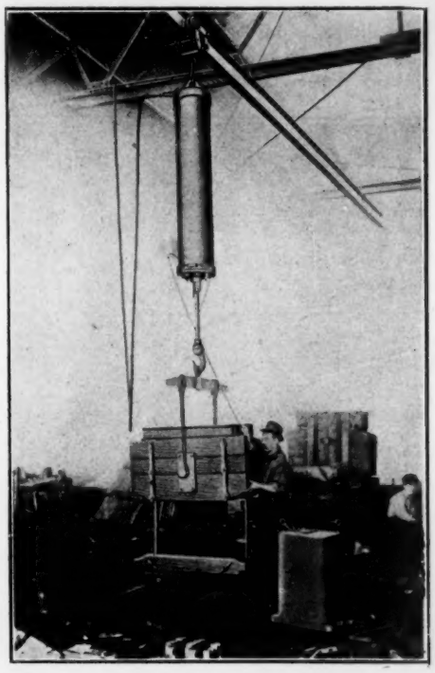

FIG. 5—THE AIR HOIST USED FOR HANDLING MOLDS

sand to the machine by a suction system and some by gravity. They all operate inside of an outer case closed by sliding, swinging or rolling door, and connected to an exhaust system.

An efficient sand blast or sand blast tumbler, either of the high or low pressure type, will remove sand and scale, and will leave castings better looking than either a plain rumbling machine or the emery brick, wire brush and pickling tank. Castings have been cleaned and their cores cut out in less than an hour each with the sand blast that could not be cleaned by hand in two days. I know of one plant where a sand blast tumbling barrel replaced a pickling tank with the result that shipments could be made at least one day earlier than before. The product

FIG. 6—THE USE OF PNEUMATIC CHIPPING HAMMERS FOR CLEANING CASTINGS

required galvanizing and was sand-blasted and put in the galvanizing bath the day after it was cast instead of losing a day in the pickling vat.

The casting now being clean the fins, etc., are chipped off with a pneumatic chipping hammer. One man chipping with a chipping hammer is as good as two or three with hand chisel and sledge, and the work looks better and smoother. A skilled chipper will quickly remove fins or bunches so that they appear scarcely to have existed.

A few words about the care and upkeep of pneumatic tools. Before attaching a tool, blow out the air line and squirt oil into the valve. Do not use an air hammer all day long without oiling it. If the hammer has not been used for some time, squirt a little kerosene or benzine into it, connect up the hose, operate the machine for a few strokes, then disconnect and squirt a light machine oil, or sewing machine oil, into the hammer. Several of the large oil refiners now supply a special pneumatic tool oil which should be used if possible. New hammers are always furnished with a gauze strainer. This should be kept in good condition as rubber particles and rust from hose and pipes are liable to clog valve passages if allowed to get into hammers. It is a

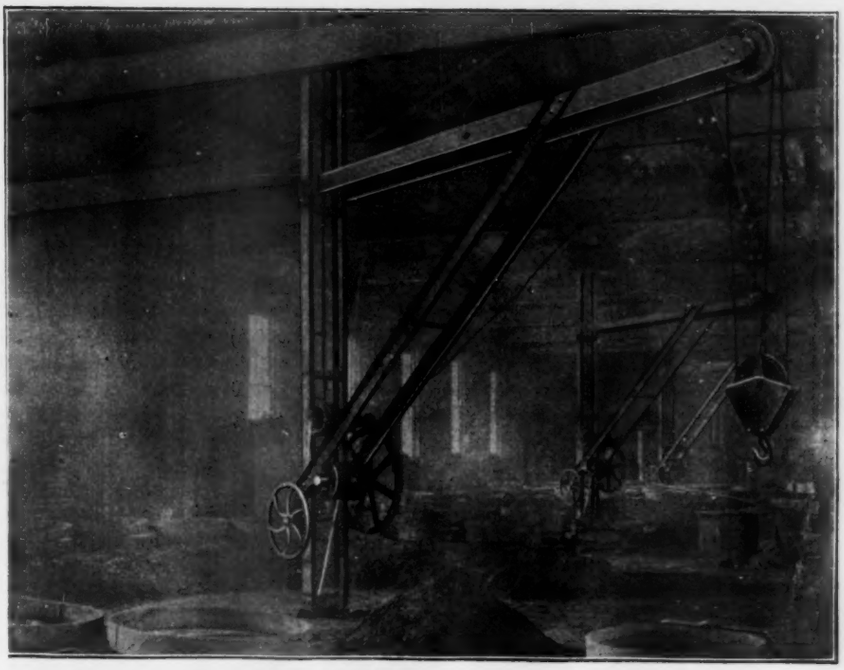

FIG. 7—JIB CRANES PROVIDED WITH AIR MOTORS

good plan to suspend the hammers over night in a bath of kerosene to clean them out and to prevent rusting from moisture in the air. They must then be lubricated before using, as the kerosene leaves them dry. There are a number of makes of automatic oilers on the market to be attached to the air line a few feet from the hammer. If none of these is used the hammer should be oiled several times a day. Chisels should be kept in shape and in general the hammer should be treated as if it were a piece of machinery rather than a piece of scrap iron.

Piping should be as direct as possible with no undrained pockets or loops where moisture can accumulate and where freezing can occur

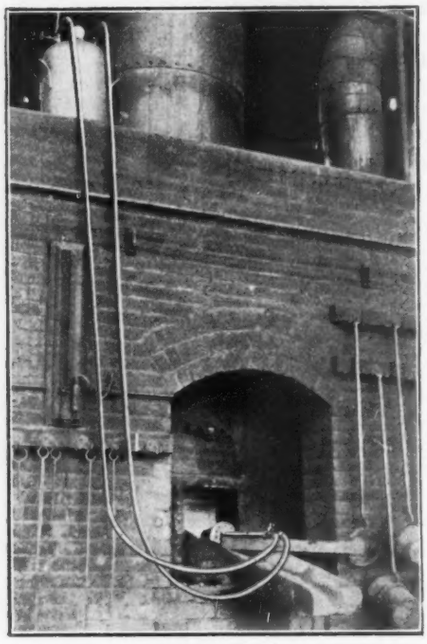

FIG. 8—COMPRESSED AIR FUEL OIL BURNER FOR LIGHTING CUPOLA

in cold weather. Separators should be installed at low points on the line. These may be either the ordinary type similar to steam separators or they may be air receivers. It is a good plan to locate a steel receiver of 25 to 50 cubic feet capacity at points where there are large fluctuations in compressed air demands. This combines the action of separator and equalizer, although it will not sustain the service if the compressor shuts down. Fittings should be of the long-turn type and all shut-off valves of the gate type. All shut-off cocks on taps should be of heavy pattern and good quality. The piping should be installed with care to insure a tight line and should be well-supported so that the joints cannot shake loose. A single ⅛-inch orifice will deliver 21.2 cubic feet of free air per minute at 80 pounds pressure. Hose should be heavy and preferably armored. Quick-acting couplings should be supplied at both ends of the hose to prevent the reprehensible practice of twisting it before screwing it into a tool connection.

After-coolers and reheaters are usually unnecessary with foundry outfits, but where there is a plentiful supply of cooling water the use of a properly proportioned after-cooler will remove nearly all the moisture from the air before discharging the air into the pipe line.

The average jobbing foundry requires a compressor of 300 to 500 cubic feet per minute displacement. Large foundries may use up to 1,500 or 2,500 cubic feet. Specialty foundries frequently require small machines of 50 to 100 cubic feet displacement. In selecting a foundry compressor, price should not be considered so much as service. The foundry compressor should be as nearly dirt-proof and fool-proof as possible. Machines that would give perfect satisfaction when operated in connection with a power plant and in charge of skilled engineers frequently go to pieces when installed in a foundry where skilled mechanics are not available, and where dirt and dust abound. These remarks refer not so much to the large foundry which maintains a power plant either for itself or jointly with other departments of the works, as to the independent jobbing foundry which produces a large percentage of our total foundry product.

In discussing compressed air in the foundry one could easily digress in many directions, for compressed air is so thoroughly applied in the up-to-date casting shop that a discussion of its use is a discussion of modern foundry practice.

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## Alloy Nomenclature

In a paper presented before the Institute of Metals, W. Rosenhain directed attention to the confusion caused by the present method of naming alloys, as the name rarely indicates the true nature of the alloy. In some cases it is misleading, as indicated by an alloy consisting essentially of copper and zinc, with not more than 0.2 per cent manganese, which is known as manganese bronze. He added that no distinct line of demarcation exists between such products as brass and bronze, and that confusion follows when alloys of copper, zinc and nickel are described as German silver. This also applies to aluminum bronze, for if the term bronze is taken as implying an alloy of copper and tin, the same term is misleading when applied to the copper and aluminum combination. The speaker recommended that a committee be appointed by the institute to evolve a system that would be generally acceptable, and offered the suggestion that the system be based on the principle of regarding alloys as essentially binary compounds. Each group of fundamental binary alloys should receive a general class name, the various members of the class being then distinguished by the addition of certain words or syllables to the class name. The entire class of alloys in which copper and zinc predominate would thus be known as brasses, and the corresponding alloys

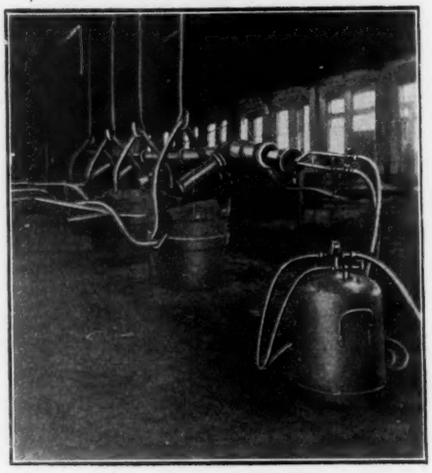


FIG. 9—ARRANGEMENT FOR HEATING FOUR LADLES WITH ONE OIL BURNER

of copper and tin as bronzes. The alloys of copper and aluminum, and copper and nickel, might be called by the names of the constituent metals as cupro-aluminum and cupro-nickel.

The system of classification, it was stated, would be quite simple in its application to commercial alloys. Naval brass, for instance, would be termed tin brass, and airch metal, which consists of copper, 60 per cent; zinc, 38.2 per cent, and iron, 1.8 per cent, would be known as iron brass, and brasses containing large proportions of lead would be termed lead brass. In the case of such alloys as electrum, containing copper, 51.61 per cent; zinc, 22.58 per cent, and nickel, 25.81 per cent, a little difficulty might arise, as strictly speaking, the term zinc-cupro-nickel should be applied, but might be conveniently contracted to nickel brass.

# Making Basic Open-Hearth Steel for Castings*

## *How the Furnace Should Be Constructed and How the Bath Should Be Worked, With a Few Hints on Pouring*

By H F Miller Jr

FOR SOME years the prejudice against basic open-hearth steel for castings has been gradually decreasing. Still, many consumers and engineers cling to acid steel for castings because of the claim made that the castings are more free from blowholes and sponginess. Acid steel has been used for castings for a much longer period than basic steel and, therefore, the melters having had longer experience in acid practice for castings, had it well in hand when basic steel was first tried for that purpose.

The heat should be melted down as speedily as possible so as to prevent excessive oxidation. The hearth of the furnace, however, is a decisive factor in the production of solid castings. First, the manufacturer should know the size of the heats he intends to make constantly. Then he should have his furnace built for that size heat. The hearth should be of dimensions different from those of a furnace making ingot steel, that is, the bath should be deeper and should have less surface area.

A shallow bath permits the slag to come out soon after the steel commences to flow and prevents the additions from going into the steel, or an even distribution in case the additions have been put in hurriedly.

Under this head comes the very poor practice of making small heats in hearths of a much larger capacity. For example, if a 25 or 30-ton furnace is in use and only 12 to 15 tons of metal are charged per heat, the proportion of heats that will be wild or show signs of wildness sometime during the pouring will be comparatively large. Whereas, when charged to capacity, a heat showing signs of wildness will be a rare occurrence.

### *Influence of Slag*

The nature and action of the slag is a very important factor in the manufacture of quiet steel. Slags are usually roughly classified by the melter according to the physical appearance. First is the dry, heavy slag, occurring when there is very little silica present. This is a dangerous slag if not carefully worked. The burning of many furnaces is due to this slag as it reflects the heat to the roof. Another danger is the addition of too much fluorspar. The melter being deceived in the physical appearance of the slag, adds an excessive amount of spar. This results in a badly cut ladle and the burning off of the stopper rod. These disastrous results can be prevented by a gradual addition of spar until a wet slag is created, after which the heat may be worked down as usual. With natural gas the heat will foam for some time.

The second slag is wet, but lumpy. This is a good slag to work with. The lumps of limestone should be broken with a rod so that a rocky bottom may be avoided. In some cases the unbroken lumps will choke the tap hole while tapping out, and the slag being stopped, the steel is left uncovered until the tap hole can be freed of the lump of limestone, a large amount of heat being lost from the steel thereby. A lumpy slag can be avoided by charging small size limestone.

A third slag is the very watery variety, usually occurring when heats melt high. This is due to the presence of an excessive amount of silica. This slag should have burned dolomite or raw limestone added until a thick slag is made.

If a heat having a thin slag is tapped, the slag will mix with the steel and a wild steel will be the result. The ladle and stopper rod will be badly scorified and usually some tons of steel will be lost in the pit due to a burned-off stopper rod.

The ideal slag is heavy and wet with no large lumps. This slag makes an easy heat to work and gives a steel low in phosphorus and sulphur. It requires but a small amount of fluorspar to put this slag in shape for the ladle. A heavy slag of this nature will not mix with the steel and will generally stay in the furnace until the steel is nearly all in the ladle. It also has the good quality of cutting neither the stopper rod nor the ladle brick. The only objection is that it causes a dirty bottom and unless a washout is made after each heat, the bottom will rise to the sill plate level in every few heats. This result shows very poor practice and no time is ultimately gained by charging without the usual washout.

If a washout of 20 to 30 minutes is made after each heat the furnace will work fast for a much longer time. Also, the holes that occur in a high bottom will be largely avoided if the bottom is kept low and clean.

### *The Tap Hole*

The tap hole should be kept large and low. The quicker the steel gets into the ladle the more heat is retained. The shorter the spout, the better it is for the same reason. Also a tap hole, if large, will not clog up easily if rabbling has to be done. In shutting up the tap hole, magnesite is best as it does not burn together, thus making a hard tap. Magnesite does not boil out as is the danger when a tap hole is shut with green dolomite. Burned dolomite is safely used for the above purpose.

These facts are probably known to most melters, but unless vigilance is constant one factor is apt to be overlooked. For example, the bottom may be low, tap hole all right, but the spout not being made up smooth at the end, causes the stream to spray over the ladle, thus losing much heat and causing a skull and some misrun castings. These could have been avoided if the spout had been made carefully.

The addition of alloys may be made in the bath or ladle. By putting the alloys in the bath, much heat is saved. This is a valuable method where a furnace is working cold or a heat has melted low and there is difficulty in getting the heat hot. The advantage is that the additions are made while the flame is still on the bath and the loss of the heat in the bath caused by dissolving the alloys can be regained. The objections are:

First, that a larger amount of each alloy must be added as about 15 to 30 per cent goes into the slag this way.

Second, that the silicon reacting will throw back the phosphorus into the steel.

The second method of putting the additions into the steel as it goes into the ladle is, in the author's

*Presented at the Cleveland meeting of the American Institute of Mining Engineers.

opinion, the best. A uniform distribution of alloys is attained by shoveling the alloys in gradually. If the alloys are added in the ladle and they are first raised to a red heat, the steel will be helped greatly. This is especially true in winter.

*Working the Steel*

After the heat has melted and the limestone boiled, the heat will be benefited by allowing it to soak for 15 to 30 minutes. This will allow any slag to rise and also, much of the gases. Ore may then be fed, if necessary, or if the heat is ready, it remains only to get the steel hot.

Sometimes heats will melt low, and if one is hampered with small ladles or if there is no heavy work to pour it in, it is best to get the heat ready by using manganese. This will not add much metal to the bath and it is a good substitute for pig iron. Where there are large ladles the writer recommends working the heats with both pig iron and manganese. Very little, if any, ferro-silicon should be used instead of manganese as the silicon mixes with the slag and cuts the stopper rod off when the heat is being poured.

Hot metal is preferable to cold additions, as the bath is not then chilled by the addition.

The great danger in working stickers is, as usual, the working of the slag. The slag often looks thick and heavy due to a cold bath. The mistake is made constantly of adding too much fluorspar. The result is that when the bath begins to pick up heat, the *slag turns to water.* If the heat is tapped with the slag in this condition and it takes more than 30 minutes to pour, the steel remaining in the ladle will be lost, as the stopper rod will be burnt off and the ladle badly cut. On the other hand, if the slag is watery and the attempt is made to thicken it, much heat will be lost and more time consumed before it will be ready to tap. This suggests the rule, "add fluorspar sparingly" and expensive mistakes will be avoided.

If the slag comes too quickly and the additions must be made in the first part of the heat, an even distribution can be obtained by rabbling the heat. If some of the additions are lost in the slag or not enough have been put in for the heat, which shows signs of wildness, a simple scheme consists of taking a number of sticks of aluminum and bending a tapping rod around them. The aluminum is then thrust to the bottom of the ladle, stirred around, and the bath rabbled afterward if necessary. There is hardly a heat that cannot be made absolutely quiet by this means. But it is a curative treatment, and a good preventive is always better.

The time consumed in pouring is a factor in determining the size of the heat. Good practice demands that a heat of steel should be poured in less than 60 minutes, the faster the better. To take longer than that length of time results in a reaction between the steel and slag. This reaction causes:

Loss of silicon and a gain in phosphorus and sulphur in the steel,
Steel shows wildness,
Skulling of ladle,
Misrun castings,
High ladle cost due to cutting of the brick by the slag,
The stopper rod becomes too hot and bending causes the loss of the remaining steel.

Again, the higher temperature, required to pour steel from one to two hours, causes a great gain in occluded gases and necessitates an increase of about 30 per cent of ferro-silicon to make it as quiet as when a lower temperature is used.

The use of spar seems also to make the steel less responsive to the quieting action of silicon as the fluorine seems to be absorbed by the steel. The writer has noticed, when pouring a test, that after much spar has been used, the steel gives off a smoky gas of the same appearance as when fluorspar is added to the bath. If this is true, the action of fluorspar cannot be beneficial to the steel when added in large quantities.

## Difficulties in Making Sound Castings

*By W. J. Keep*

The casting with which difficulties were experienced was an engine liner, 4⅝ inches inside diameter and 15 inches long. The walls were ¾ inch thick, with a ring around the center, 1⅜ inches thick and 2 inches wide. A mold for a casting of this type should be poured on end with the iron entering the bottom and should be filled quickly. The inquiry regarding this difficulty was received from abroad, but in this country it is the practice not to make the liner as thick as ¾ inch, and if it is advisable to make the ring a part of the casting, it should be lighter than noted. The gate should extend down one corner of the flask and a riser may be arranged to allow a small overflow to eliminate slag, dirt, etc. If necessary, the mold can be fed through this riser to overcome the shrinkage. As the grain of a casting of this thickness is liable to be coarse, and as a close grain is desired, the casting should be made as light as possible. The casting should be hard, but machinable. The lower the silicon, the closer the grain, and if the casting is too heavy and cools too slowly, an iron mixture must be used, which will become solid so quickly that the grain will be close. The thicker the walls of the casting, the lower must be the percentage of silicon. In this case the silicon content should be 2 per cent. However, if the grain is too coarse, the percentage of silicon should be reduced. Undoubtedly it is the impression of this manufacturer that the scrap he is using contains less silicon than his pig iron, but probably the reverse is true.

With reference to the use of steel in the mixture, it is probable that a 22-inch cupola is of insufficient size for this practice. However, the experiment might be tried. The pig iron and scrap should be broken into small pieces, not over 1 foot long, and the iron should be melted hot before the steel is added. The latter should consist of boiler plate clippings and punchings. Add approximately 10 per cent of steel, which should be considered as scrap in calculating the mixture. If this can be melted in the cupola, the grain of the iron will be much denser than it is at present. Use oyster shells, marble chips or limestone as a flux in the proportion of 20 pounds to each ton of iron melted. Add 0.1 per cent of commercially pure aluminum in the ladle to clean the iron and to make it more fluid. It will be advisable to obtain an analysis of the pig iron which is being used, and this undoubtedly will be furnished by the blast furnace furnishing this material.

## Producing Colors by Electro-Deposition

A new process for the production of colors by electro-deposition, which promises to be of value in the finishing of art metal goods, hardware and metals of similar character, has been invented by F. A. Rogers. The process is electro-chemical in nature and it is claimed that depositions of any desired color can be produced from the electrolytes and by proper combinations any effect can be obtained from the most delicate tint to the antique and modern bronze finishes.

# THE BRASS FOUNDRY

## Copper Alloys for Motor Car Service*

By W H Barr

IN OFFERING a paper on copper alloys, one approaches a subject of such magnitude that it can only be treated briefly, in a manner that may prove of interest and service to automobile engineers. The basic ingredients of bronze and copper alloys are, of course, copper, tin, zinc and lead, and we will consider these metals from a viewpoint somewhat unusual. Men of mechanical training, especially those who have not made a study of metallurgy, are always interested in knowing something of these virgin metals, their origins, and their effect upon each other, when brought into alloys or combinations.

### *Copper*

Copper was probably the first metal used by the human race. Weapons and ornaments have been found which seem to prove that the men of prehistoric ages made use of it on account of the ease with which it could be worked, and the fact that it was found in the ground in the metallic state. It is claimed by many that its use antedates that of iron. The copper mines of Wady-Magrah, located in upper Egypt, are thought to have been worked as early as the second dynasty, about 3,000 B C.

The Romans claimed that their best copper was obtained from Cyprus, an island in the Mediterranean, and for this reason the metal was known as *Cyprian brass;* later, the contraction to *cuprum,* and then to *cuper,* from which our present term *copper* was derived.

In the United States, copper is usually classified in three grades: Lake copper, that brought from the Lake Superior region; electrolytic copper, that refined by the use of electric current, and casting copper, that which is not entirely refined, but carries varying amounts of impurities, and as a result, is rapidly disappearing from the commercial fields.

In bronze and brass alloys, copper is the predominant metal, being the element with which we can best alloy smaller quantities of other metals. The essential characteristics of copper are to impart strength and toughness, and in ornamental work, varying degrees of rich, red color. It is the best conductor among the metals, of both heat and electricity, slightly excelling silver in the latter respect.

Chemically-pure silver was, for years, believed to have the highest electrical conductivity of all the metals, and accordingly was the basis for the 100 per cent standard. Recently, however, copper has been produced in so excellent a state of purity as to indicate an electrical conductivity of 104 per cent.

The United States produces more copper than any other country, or about 65 per cent of the total output of the world, the total amount for 1911 having been 1,090,000,000 pounds. The first mine worked in the United States was the Simsbury mine at Granby, Conn., in 1705, which proved to be of little value and only small amounts of copper were taken from it.

The specific gravity of copper is 8.82; melting point 1,981.5 degrees Fahr., United States bureau of standards; the tensile strength varies with the physical conditions, producing the following results: In cast copper, the tensile strength is 26,000 pounds per square inch; in bolts 34,000 pounds, and in wire, 55,000 pounds.

The tempering of copper has for years been considered a lost art, but among the latter-day scientists, the unity of opinion is that this climax of the art never existed.

### *Tin*

Tin was first known about the time of Moses, or 2,000 B. C., and it has been produced in varying quantities ever since. Tin was imported by the Phoenicians from the British Isles long before the Christian era. These islands were, on this account, known as the Cassiterides, from the Greek word Kassiteros, meaning tin.

Tin stone, which is an oxide of tin, is, at the present time, the only ore used for the production of metallic tin, and is found in the largest quantities in the Malay Peninsula (Chinese) and the Island of Banka (Dutch East Indies). The total world's production of tin in 1911 was 233,504,000 pounds, of which the United States consumed about 40 per cent.

Tin is a white metal with a distinctly yellowish tinge, and can be rolled into very thin sheets, but its low tenacity prevents its being drawn into wire. Its specific gravity is 7.29 and its melting point, 449.4 degrees Fahr. It has a distinctly crystalline structure and emits a peculiar crackling sound on being bent back and forth, due apparently to the rubbing of the crystals on each other.

The smelting is a comparatively simple operation, as the oxide is readily reduced by carbon at a red heat. The purest metal is obtained from reverberatory furnaces. This is further refined by liquation, which consists in subjecting the metal to a low temperature on a sloping hearth, where the tin, having a low melting point, runs out, leaving the impurities behind.

### *True Bronzes*

Tin produces a decided tempering effect in combination with copper, varying in proportion as it is used. Above 25 per cent tin, the alloy is too hard and brittle for use. The true bronzes are alloys having these two elements as their main constituents. Up to about 10 or 12 per cent tin the material is not affected by quenching. Above that percentage quenching to the proper temperature renders the alloy softer than if slowly cooled, being directly opposite the effect

*Presented Nov. 7 before the Detroit Section of the Society of Automobile Engineers.

which such treatment has on steel. Tin also has a high coloring effect on copper, a very small quantity being distinctly discernible. Tin in combination with the brasses or copper zinc alloys, when present in small amounts, renders the alloy more sound, more fusible and capable of taking a better polish.

*Zinc*

Zinc, commercially called spelter, is the next important metal. It is of a bluish white color, of a decided crystalline nature, and at ordinary temperature, quite brittle. Between 250 and 300 degrees Fahr., however, it is malleable enough to permit of rolling into thin sheets and drawing into wire. Zinc is not found in a free metallic state, but is obtained from its ores, which are chiefly sulphide of zinc and carbonate of zinc. The concentration of the ore is attended with considerable difficulty, as the associated impurities are generally of about the same weight as the ore.

The specific gravity of cast zinc is 6.87, and its melting point, 786.9 degrees Fahr. It is a poor conductor of both heat and electricity.

The United States is the largest zinc producer of the world, New Jersey, Missouri, Kansas and Colorado containing the greatest deposits. Our total output in 1911 was 623,122,000 pounds.

Of the different metals that we are considering, zinc is the only one that can, of itself, properly be called a bearing metal. Used unalloyed for bearings where strength is not essential and its brittleness is not objectionable, there is probably nothing superior to it for wearing qualities.

Zinc in combination with copper produces the brasses. Very small additions of zinc render copper suitable for casting. Larger additions cause gradually increasing hardness, but not to as marked an extent as tin. Nearly 50 per cent zinc can be added before an alloy too brittle for use is obtained. With increasing zinc contents, the strength and elongation, as well as the fusibility of the alloy increases. The coloring effect of zinc on copper is not as immediate as that caused by tin.

*High Bronzes*

In the high copper-tin bronzes, zinc is used in small quantities of about 1 or 2 per cent, mainly for a cleansing effect. It improves the fluidity of the metal, thus making sharp, clean castings, free from blow-holes. With a higher percentage, the hardness and strength of the bronze decreases, and the brass-like qualities thereby imparted, become apparent.

*Lead*

Lead has been known from remote antiquity. It is mentioned in the Bible at a period of about 3,000 B. C., and articles made from the metal by the ancient Romans, in the form of water pipes, tanks, rings, etc., are still preserved. Many European countries produced lead as early as the tenth century and still supply the market. The United States leads the world at present, the annual production for 1911 having been 795,628,000 pounds, or about 40 per cent of the world's production.

The first lead in the United States was discovered near Jamestown, Va., in 1621, but the present main supply and the richest ores are obtained from the western states. The principal ore is the sulphide called Galena, which almost invariably carries a small percentage of silver. The specific gravity of lead is 11.35, melting point 621 degrees Fahr., and the tensile strength, 2,000 pounds per square inch.

Lead, in combination with copper, is exceedingly difficult to introduce in its best form and remains undissolved as inter-crystalline material. It is, therefore, not an alloy, but rather a mechanical mixture. The action of the lead in combination with a copper-tin bronze is as a lubricant, the small, free globules of lead in a bearing being very beneficial.

Although lead makes the alloy dense and malleable, it has a decidedly weakening effect in that its globules break up the continuity of the crystals. A high lead bronze, 10 per cent and more, when broken, will show a gray fracture as a result of breaking through the weaker lead globules and not through the crystals of the copper-tin mixture. The same fracture, if finished and polished, will show the proper red color of the particular alloy. In brass, lead also acts as a lubricant and prevents fouling of the tools in working.

*Phosphorus*

Some elements, such as arsenic, antimony and sulphur, have a detrimental influence on bronze, but there is one which has a decidedly beneficial effect, and that is phosphorus. The function of phosphorus on a bronze is that of a deoxident. It cleans the metal from oxides of copper and tin, and if the correct amount is used for this purpose, none remains in the finished alloy. By the removal of these oxides the bronze is rendered more fusible and better castings are possible. Larger additions of phosphorus harden the metal, but at the expense of toughness. The production of various qualities of phosphor bronze depends more upon the proper proportioning of the various ingredients than upon the quantity of phosphorus.

One of the problems which must be contended with by the sales department of a brass foundry is the lack of information about phosphorus, which results in ridiculous specifications, often asking for a phosphorus content as high as 10 per cent. The specification of phosphorus can with safety be left only to the metallurgist, instead of the ordinary brass foundry foreman, who usually relies entirely upon guesswork. Phosphor bronzes should be secured only from companies of reputation, who make a specialty of their manufacture.

*High Copper Alloys*

High copper alloys, as related to motor car construction, may be divided into four classes: Soft phosphor bronze, hard phosphor bronze, red brass and yellow brass.

Soft bronzes in general are low in phosphorus and high in lead, the former being used solely as a purifying or deoxidizing agent. This class of bronze can only be considered for bearings, the high percentage of lead reducing the tensile strength of the alloy, so as to make it unsuitable for severe strains. Under this head may be mentioned one of the standard alloys, 80 copper, 10 tin and 10 lead. This combination is generally used throughout all motor car construction, and present practice among the best makers finds use for the alloy in a number of places.

It is difficult to recommend this or any other alloy to render the best service in any part of a motor car without the specific knowledge of conditions covering its use. Before making an intelligent selection it is necessary to know the bearing pressure, character of lubrication and amount of vibration, as well as the nature and quality of the steel which is used in the rotating piece.

*Hard Phosphor Bronzes*

Those phosphor bronzes commonly described as hard are generally high in both phosphorus and tin, and low in lead contents. In those cases where the phosphorus content runs as high as 1½ per cent, the tin content is necessarily under 12 per cent, or the alloy would be too brittle. The reverse is also the case and where alloys contain a mixture of approximately 80 copper and 20 tin, the

phosphor contents should not be over 0.5 per cent. An alloy of this character is used to withstand heavy pressures and has no place in motor car construction.

Among the high copper tin bronzes may be classed the gear bronze most generally used in the United States and abroad, being an alloy of 88 or 90 copper, and from 12 to 10 tin. No standard gear bronze has yet been adopted by the alloys committee of the Society of Automobile Engineers, owing to the lack of unanimity of opinion as to what is best to recommend. A few prominent manufacturers of bronzes have their own special formula, which in some cases may be superior to a formula of 88-12, or its approximate.

*Successful Gear Bronzes*

The composition of 90 copper and 10 aluminum has proven one of the most successful gear bronzes on the market, having an average tensile strength of 60,000 pounds, often reaching 65,000 pounds per square inch. It has wonderful bearing qualities. It has not been generally used owing to the difficulties encountered in its manufacture, only one or two makers having solved the problem of producing perfect castings.

The alloy of 88 copper, 10 tin, 2 zinc, probably the most prominent of the United States standard alloys, fills many requirements most satisfactorily and for all around use is hard to improve.

Red brass, commonly known as *composition*, contains a maximum of 85-86 per cent copper. In this way it can be differentiated from the bronze class. Too often, red brass is only an excuse for a visit to the scrap pile on the part of mediocre brass foundrymen, where the scrap, selected with varying degrees of care, depends largely on what the customer will accept. Fortunately, this condition is being remedied, and that type of brass foundryman is being eliminated, through the demand by automobile engineers for a brass of uniform color and texture.

One of the S. A. E. standard alloys which has given excellent satisfaction is 85 copper, 5 tin, 5 lead and 5 zinc. This alloy has an excellent color and may be used in motor car construction where severe bearing necessities or great strength is not a requirement.

Yellow brass may be sub-divided into two classes, one being the type of brass used generally for ornamental purposes. The other is manganese bronze, in which the percentage of copper and zinc runs close to yellow brass. Its tensile strength and other remarkable properties are brought about by the use of small quantities of iron, manganese, aluminum and tin, in varying proportion. Manganese bronze being very generally used either for experimental or permanent construction, should not be passed without comment.

If it is the intention to use the casting where rigidity is required, the manufacturer should be so advised. By slightly changing the composition of manganese bronze, it is possible to alter its rigidity and consequently, its ductility, to a marked extent. In specifying for manganese bronze castings, it is wise to adhere to established brands, particularly where the work is being done by your own or a local foundryman who perhaps lacks the metallurgical knowledge necessary to produce or even judge a good ingot metal. Unscrupulous refiners of scrap metals frequently offer for sale, under the name of manganese bronze, an ingot which would be decidedly out of place in a yellow brass classification.

Manganese bronze may be used for practically all brackets, foot levers, radiator braces and all external parts requiring strength in the body. This covers the brakes, lugs, levers, hubs, spider, steering yokes, fan pulley, dust covers, plates, brake lugs, windshields, handles, supports, hinges, buttons, latch, foot adjustment, quadrant, and any parts, not including bearings, which require the strength of high grade steel or drop forging.

*Bearings*

The correct and practical solution of the severe bearing requirements on the modern high-speed gasoline engine is of the utmost importance. In designing engine bearings, there are two important conditions that must be taken into consideration. First, the selection of a proper alloy, having the requisite anti-frictional qualities, and secondly, the selection of a metal having the necessary physical properties as regards strength and resilience. The latter property is the one too often neglected.

A soft babbitt may have the anti-fricitional requirements necessary for gasoline engine service, though owing to its plastic nature, its physical properties render it unsuited for the work. On the other hand, a bearing made entirely of steel would have the necessary strength and resilience, but would not be anti-frictional. These anti-frictional qualities are so obviously imperative that in nearly every case these have been considered at the expense of the mechanical or physical properties of the bearing. Soft babbitts have been discarded, and for the reason stated, harder babbitts have been substituted; in many cases, die-cast bearings have become generally used as crank bearings in some classes of motors.

In the light of the foregoing facts, it is not a difficult task to design the ideal bearing, for it resolves itself into combining the best anti-frictional qualities with the highest physical strength and resilience. These qualities have not been found in any one metal or alloy now known.

*The Ideal Bearing*

It, therefore, becomes necessary to unite these characteristics in a bearing, and this is done by adopting the old-fashioned babbitt lined bronze shell of a modified design. For the bearing surface requirements, we select a high tin, so-called genuine babbitt, containing about 90 per cent tin, and approximately 5 per cent each of antimony and copper. This alloy adheres readily to the bronze shell and in its formula, is close to several well-known brands. A variation of 1 per cent in any of the constituents will not materially affect the result. For the necessary physical property, we select a copper-tin bronze having high strength and resilience. The constituents of this bronze should be so proportioned, that upon cooling, from the molten to the solid state, there is no eutectic formed, that is, no small portion of the alloy may have a lower melting point than the greater part of the mass.

The alloy should possess perfect homogeneity, and it should not deteriorate when subjected to alternating mechanical strains and changes of temperature, as would an alloy which is not free from one or more eutectics. Furthermore, s t r e n g t h should not decrease with an increase of temperature. It should be strictly a resilient metal, in that it should have the least tendency for crystallization under shock and mechanical strains.

The bronze-babbitt-lined shells are naturally adapted to the construction of the highest class of motors, in that their rigidity makes them less conformable to a lower grade of workmanship, since they must be machined accurately in order that they may give the highest possible service.

On the other hand, the genuine babbitt, die-cast bearings are suitable for fairly high class motor construction, as they lend themselves more readily to the construction of a moderate

priced motor where the necessity for the superlative degree of accuracy of machine work and design does not exist.

It may, therefore, be concluded that the use of the die-cast babbitted bearings are adapted for motors of moderate price, and the bronze babbitt lined shells for the very highest class.

The permanently successful use of bronze or brass in any form can only be maintained by those engineers who recognize the necessity for improved and scientific methods. Within a comparatively short time the metallurgist and the laboratory have become recognized factors in brass foundry practice.

From the standpoint of the automobile engineer, it would seem that the same detailed attention should be given to the non-ferrous alloys in motor car construction as is given to steel products and appliances. Too often, the decision as to what brass or bronze may be used, is left to the purchasing department, where price alone usually governs the selection.

# BRASS FOUNDRY DIFFICULTIES

## Solved by Experts

### Cheap White Metal Alloy

*Can you furnish us with a mixture for a white metal alloy which can be utilized as a substitute for brass? This alloy will be subjected to 75 pounds hydraulic pressure and the metal should be sufficiently hard to permit of being threaded. The cost of the alloy, furthermore, should be moderately low.*

The following mixture probably will meet your requirements: Zinc, 85 per cent; copper, 8.5 per cent; tin, 4.5 per cent, and aluminum, 2 per cent. Melt about 30 per cent of the zinc, add the copper in thin strips and allow the metal to become sufficiently hot to dissolve the copper. Next add the remainder of the zinc, which will cool the alloy to a normal temperature, thereby avoiding excessive volatilization of the zinc. The tin and aluminum, which were previously alloyed, are added last.

### Shrinkage Difficulties

*We are experiencing considerable difficulty in obtaining some brass castings which form the links of a loom chain. Eighteen castings are poured through one gate, nine on either side, and the mold is set on end, being poured vertically. Some of these castings are almost hollow, although others are sound. The mixture we employ is an ordinary 2 to 1 yellow brass, containing about 2 per cent of lead.*

It is probable that the difficulty in this case is caused by shrinkage, the metal being drained from the castings in the upper part of the mold by the shrinkage of the castings in the lower part of the mold. What actually occurs is similar to slush molding. In this process, the mold is filled with metal and after a shell has been formed by the chilling contact with the walls of the mold, the molten center is poured out, thereby forming a hollow casting. The defective loom chain castings have their centers drained by the shrinkage of the metal. To remedy this difficulty, it might be advisable to cast the links horizontally instead of vertically. The mold should be slightly tilted at one end, approximately 2 inches being sufficient, with the pouring end at the highest elevation. The amount of metal in the sprue will be sufficient to feed all the castings in place of one casting feeding another. Another remedy would be to continue pouring vertically, as you undoubtedly are equipped for this method, but to alter the gate so that each branch gate curves downward. Then it would be impossible for the metal to drain from the individual castings. Another method would be to make the vertical runner slightly heavier and if tapered toward the bottom, the greatest mass of metal would form the upper part of the gate and would be in position to feed all the castings, as the vertical gate would be well filled with metal during the period of shrinkage.

### Yellow Brass

*We would like to have a formula for a yellow brass mixture that can be buffed and machined easily. We desire to use a large percentage of scrap.*

An excellent brass mixture, suitable for the work mentioned, follows: Copper, 79 per cent; zinc, 16 per cent; lead, 3 per cent, and tin, 2 per cent. Any desired amount of scrap can be used, but judgment should be exercised in its selection, as it will undoubtedly contain all the lead and zinc that it can carry. The zinc probably can be ignored, or if necessary, a few extra pounds can be added to the heat containing 50 per cent of scrap. The lead and tin should be the same as for a full heat of new metal. For example, sheet scrap, 50 pounds, zinc, 30 pounds, tin, 2 pounds, and lead, 3 pounds, will make a fairly good mixture.

### Bell Metal Mixtures

*We recently made a number of bells, weighing from 100 to 150 pounds each, and used a mixture containing 78 per cent of copper and 22 per cent of tin. A number of smaller bells, weighing from 25 to 50 pounds, were made of a mixture consisting of 80 per cent copper and 20 per cent tin. The purchaser, however, stated that he desires a deeper tone, and we were wondering whether this could be accomplished by increasing the percentage of copper in both mixtures. Kindly advise us to what extent the copper should be increased and tin decreased, if this is the proper method of procedure. We melt the copper under charcoal, the tin being added after the metal is removed from the furnace.*

Instead of decreasing the tin in the bell metal mixtures given above, it would be advisable to add to the first mixture, 1 pound of manganese-copper and 2 pounds of phosphor-tin, and to the second mixture, after the copper is melted, an addition of 1½ pounds of yellow prussiate of potash should be made. The latter, also known as potassium ferro-cyanide, occurs in large yellow crystals. This salt should be dropped upon the surface of the metal and should not be disturbed until the water of crystallization has been evap-

orated. Then the stirrer may be introduced cautiously and the metal is vigorously stirred. The tin is added next and the metal is ready for the molds. While the method of treatment outlined is recommended for any bell metal mixture, it may not give the deep tone desired, as that is dependent entirely upon the shape of the bell and the thickness of the sound bow. To obtain a deeper tone, the thickness of the bell should be increased. If the percentage of tin is decreased, the mixture no longer can be considered as a bell metal and the alloy will lose its resonance.

## Scrap Wire Versus Ingot Copper

*Kindly advise us whether in the manufacture of engine, car and tender bearings the use of scrap copper will give the same results as new ingot copper. Our impression is that the quality of copper used in the manufacture of copper wire is better adapted to this work than copper usually purchased in the open market.*

The term scrap copper covers a wide range of material and it is necessary to differentiate between the various kinds. Heavy rolled scrap, cut into small pieces, at times will be more suitable for making alloys than ingot copper and the same applies to scrap as trolley wire. The finer grades of wire, however, present an enormous surface for oxidation and on this account are inferior to the copper in larger masses for making alloys. Owing to the excessive oxidation when remelting, wire produces castings greatly inferior to ingot copper. This applies especially to bearings, as the oxides in the metal are liable to form in patches underneath the skin of the casting, thereby resulting in heating in service. Therefore, ingot copper is best for your line of work.

## Shotting Copper and Nickel

*We are experiencing considerable difficulty in shotting pure metal, such as copper and nickel. When poured a short distance, the shot encloses water, and when poured from a greater height there is more or less surface oxidation, the metal becoming quite dark. We also are unable to eliminate sulphur, as CuS and NiS, in the slag by means of CaO+C. We operate a small oil furnace and the carbon monoxide slags off as such and cannot be made to enter into combination with the sulphur.*

If it is necessary for the metal to be in globular form, some modification of the practice followed in making lead shot probably would have to be pursued. In this case, we would suggest that the metal be poured through a perforated mold, and if the shot is discolored, the addition of a small amount of sulphuric acid to the water probably will remove the discoloration. If granulation is required, without reference to the form of the granules, the stream of molten metal should be poured onto an inclined plane, preferably made of wood, and one end of the inclined plane should be immersed in a tank of water, while the upper end should be provided with a perforated pipe, from which a stream of water at considerable pressure should flow down the plane. We do not understand where you obtain your sulphur or why it is necessary to have a slag, unless you are smelting ores, in which case a small oil furnace is not the proper medium for doing such work successfully. Your reference to slagging-off carbon monoxide also is somewhat obscure. Carbon monoxide is a gas and passes off as such or is converted to carbonic acid with the evolution of heat. When dissolved or held in suspension in the metal, this gas can be removed by deoxidizers, which remove its oxygen and liberate the carbon. In the case of copper, the carbon rises to the surface, but is liable to be absorbed by nickel and has a bad effect on this metal.

## Defective Circular Bronze Plate

*We have received an order for a circular bronze plate, 37 inches in diameter and 1 inch thick, which is to be machined on all surfaces and should be acid-resisting and withstand a pressure of 100 pounds. We have attempted to make several of these plates, but they have been condemned, as they were porous. The mixture we used consisted of 517 pounds of pig copper, 40 pounds of Banca tin, 15 pounds of lead, 10 pounds of zinc and 10 pounds of 15 per cent phosphor-copper. The plate was molded flat with several large risers.*

We would suggest the use of rice charcoal to the depth of 1 inch on the surface of the metal when melting the copper, as your trouble appears to be due to oxidation. The zinc undoubtedly is added to cheapen the mixture, but better results would be obtained without its use. Theoretically the phosphorus should insure sound castings, but as indicated in this case, it cannot always be depended upon. It might be advisable to change the deoxidizer and six pounds of phosphor-copper might be employed in conjunction with the three pounds of 30 per cent of manganese-copper.

## How to Cast Lead

*I have received an order for a large lead casting, but do not know how to proceed to insure satisfactory production. Kindly give me instructions as to both molding and pouring methods.*

Lead is a particularly difficult metal to cast, owing to its high specific gravity and extreme fluidity. The castings are liable to be rough and frequently contain many swells, as the metal searches its way into the sand and by its weight presses back the walls of the mold. We would suggest that you use a dry sand mold faced with a mixture consisting of an open sand bonded with flour in the proportion of one part to 20 of sand. Apply a thick coat of blacking to the finished mold and dry the mold until it becomes hard. Pour the lead at as low a temperature as possible and cast the metal from two or more pots. Several risers or feeders should be placed on the highest point of the casting to overcome shrinkage and these particularly are necessary if your lead contains a considerable percentage of antimony.

## Segregation of Lead

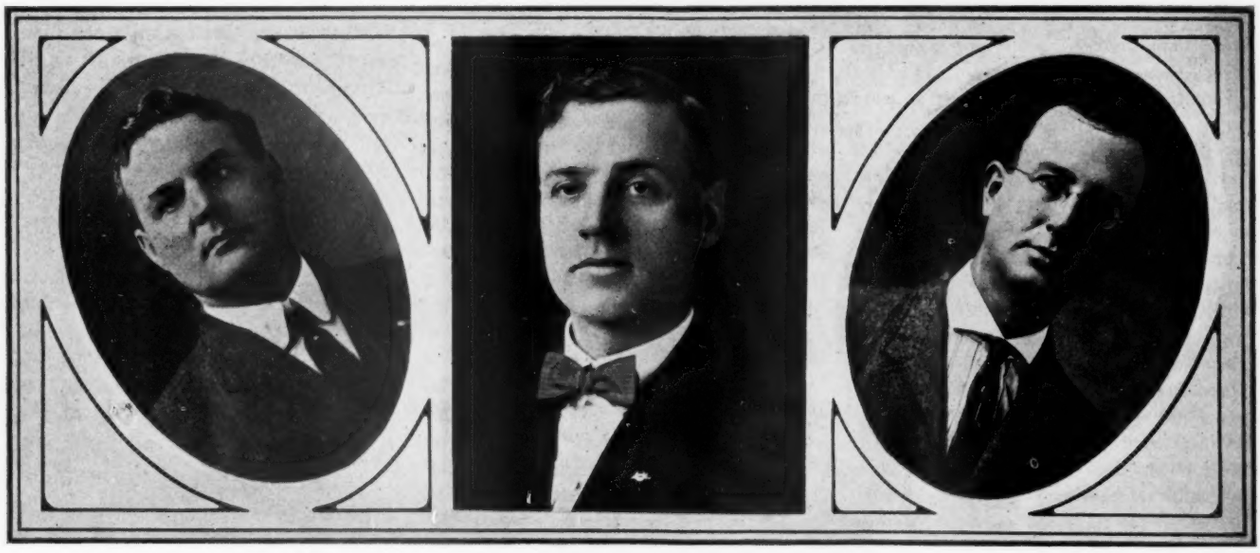
*We are experiencing trouble with scrap brass which contains lead varying from 18 to 20 per cent. When this scrap is melted and poured into the molds we find it impossible to hold the lead in the mixture and it usually lodges in the bottom of the mold. We are not permitted to increase the percentage of our copper and we are unable to overcome our present difficulties. Our line of work consists of locomotive, car and mining castings. Can you suggest the addition of some alloy which will hold the lead in the mixture? The scrap brass which causes this trouble consists of heavy locomotive driving brasses.*

You should experience no difficulty in holding from 18 to 20 per cent of lead in bearing metal, and your difficulty may be due to the lack of a sufficient amount of tin or a large percentage of zinc in the scrap metal. If the metal emits a large amount of smoke, zinc is causing the trouble, otherwise an increase to 7 per cent tin will prevent the liquation of the lead. The addition of 1 per cent of manganese-copper or the same amount of nickel might be tried and this may possibly remedy the difficulty.

# History of the Associated Foundry Foremen

*Brief Sketch of This Organization Which Has Enjoyed a Remarkable Growth, With An Outline of Its Work*

WITH AN enrollment of 350 members, the Associated Foundry Foremen enters upon a new era of activity. The annual meeting at Buffalo reflected a renewed interest in the affairs of this society, on the part of foundry foremen and superintendents generally, and the indications are favorable to a large increase in the membership in the immediate future.



ROBERT B. THOMSON,
Secretary-Treasurer Associated Foundry Foremen

ROBERT H. WALKER,
President Associated Foundry Foremen

P. M. WOODEN,
Vice President Associated Foundry Foremen

Organized in 1901, by the late Henry M. Hansen, formerly editor of THE FOUNDRY, and A. M. Louden, of the Elmira Foundry Co., Elmira, N. Y., the association has enjoyed a steady growth, although some slight change in its original purpose has been made. Mr. Louden was the first president and Henry M. Hansen, secretary, held this position until the time of his death. Charles Thomas succeeded Mr. Louden and James B. Murphy was elected secretary to succeed Mr. Hansen. David Reid followed Mr. Thomas as chief executive and Frank Everitt was secretary for a number of years following Mr. Murphy's term of office. Mr. Reid was succeeded as president by the following in the order named: James M. Webb, W. S. McQuillan, Eugene Smith and Robert B. Thomson. Among the secretaries following Mr. Everitt who resigned on account of ill health, were C. E. Hoyt, now secretary of the Foundry & Machine Exhibition Co., and Hugh McPhee.

At the recent annual meeting held in Buffalo, Robert H. Walker was elected president, P. M. Wooden, vice president, and Robert B. Thomson, secretary-treasurer. Mr. Walker is superintendent of the foundry operated by Abendroth Bros., Port Chester, N. Y., and prior to his connection with this company he was in the employ of the General Electric Co., Schenectady, N. Y., for a period of seven years. P. M. Wooden, vice president, is foreman of the foundry operated by Reeves & Co., Columbus, Ind. He served his apprenticeship with the Madison Machine Co., Madison, Ind., and worked as a journeyman molder in St. Louis, Indianapolis and Columbus, Ind. Later Mr. Wooden returned to the Madison Machine Co. in the capacity of assistant superintendent and in 1903 he was appointed foreman of the Reeves & Co. foundry.

Robert B. Thomson, who was elected secretary-treasurer, was formerly president of this organization and has had a wide experience in foundry work. He was employed in various capacities with the B. F. Sturtevant Co., Hyde Park, Mass., Brown & Sharpe, Providence, R. I., Buffalo Forge Co., Buffalo, and during the past five years has been superintendent of the foundry operated by the Buffalo Pitts Co., Buffalo. Mr. Thomason also is secretary of the Buffalo Foundry Foremen's Association and has been active in the work of this branch since its formation.

Foundry foremen and superintendents are eligible to membership in this society, which meets annually at the time and place of the American Foundrymen's Association convention. An employment bureau recently has been added, which should prove of value to members out-of-work or desiring to make changes. The dues are nominal and the members of this organization are entitled to attend the meetings of the American Foundrymen's Association and the various functions which make these annual gatherings so enjoyable.

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The Foundry Service Co., Cleveland, has been organized to consult and advise with foundrymen with a view to reducing operating costs and increasing the output. The service rendered involves a detailed study of handling labor and material with recommendations for overcoming losses that are being sustained.

# *The Buffalo Metal Fest From Two Angles*

By F Webster

JOE SWAIN, foreman of the International Foundry, is back from Buffalo. He dropped off the local at East Prairie, Ill., after an all night's ride with little sleep. The early fog hung low, and he hesitated as he stood on the switch, uncertain of his bearings, rubbing the grit from his eyes and fathering the thought that the locomotives on that line should be equipped with cinder mills. Locked to the lapel of his coat was the insignia of the Associated Foundry Foremen together with the metallic appendage with its neat identification card conferred by the "type" girl at the door of Exhibition Hall.

Finally he got the scent, walked around L. S. & M. S. coke empties back of the station platform and struck out at a lively gait *via* the sycamore grove short cut for home. Visions of a cup of Mary's coffee with some home-made bread blotted from his memory everything that had happened during the last five days. Hardly had he started his breakfast when Ben and Jay and Campbell, on their way to the foundry, walked in.

"How about the convention?" was the chorus greeting.

"Um, great!" parried Joe between gulps of coffee, corn cakes and fried potatoes. "I joined the Chicago specials. Got there Monday morning. Buffalo very hospitable. Woke up in time to take all of us in, and turned everybody else out—that is, the hotel clerk said that thousands of men were wandering the streets of the town without shelter, just because he had to accommodate us. Called single rooms double. Took us an hour and a half to eat breakfast. Paid $1.65 for two corn nubbins no bigger'n my thumb, with a little bread, butter, baked apple and coffee for manners. Oh, yes, paid a lackey extra for husking the corn. Buffalo is some town, but nothing but a bottom drop to Chicago. The show'll be out this way next year where everybody can get onto the charging platform without crowding."

### *Pursuit of the White Indians*

Joe distributed to Mary and the kiddies the souvenirs which he had bought to stop further pursuit of the white Indians at Niagara Falls, and was ready to go with the boys to the foundry.

"We wondered what you would see in molding machines," ventured Campbell as they went along.

"Great jolters, yes! If one had a nickel to place on the table of a jolter and then stood back and looked wise while the machine performed its deafening stunt, he was admitted at once to good society. Some exhibitors used a glass of water on the machine base, showing that the water wagon got no jolt in that booth. You just watched the water and then climbed the elevator to see the machine."

"How about their method of handling the copes?" asked Ben. "You know that the machine that we tried, with its foundation big enough for a Corliss engine, shook the copes into the drags unless we took the molds across the river and assembled them far away from the machine."

"Made no copes," said Joe. "Everything was in brand new flasks with the stiffest kinds of patterns. Of course, there were all kinds of squeezers and various foundry equipment."

"How did you find the mix-by-analysis crowd?" asked the superintendent later in the day.

### *The Mix-by-Analysis Stunt*

"About the same. Some were using it and others were not. Many have tried it, or are trying to follow the mix-by-analysis system, but fail to get good results, because they don't know how to use it. You remember how we beat the chemists on that big order for valve castings for the government? They sent us their specifications and formulas. We bought special irons and got as fussy in sorting the scrap as an old hen with one chicken. My, didn't the castings trek to the scrap pile! I saw their mix was not worth a darn, and on the quiet, I charged the cupola in our regular way that we always swear by. The experts took my castings and condemned their own mix, thinking that it was mine.

"I ordered some supplies and equipment from the exhibit fellows, and taken altogether, feel well repaid for making the trip."

That same evening, down in Boston, an informal party of six, with Mr. Duxbury as guest of honor, were having some eats at the Essex.

"Gentlemen, it was an educational love feast. The attendance of the membership of the A. F. A. was large, and they were there distinctly for the purpose of improving the foundry business as a national asset. With us it was system, safety, scientific investigation, education. We were honored by city officials and by the United States government."

"I read the paper which you sent me on

'Industrial Education', but I couldn't make out exactly as to how we are to get at it," said Hancock. "The boys of today will not work like we did at their age. With them it is all wages, and worse still, many of them will quit the job rather than give up their cigarettes or attend night school. The spirit of the times seems to be for recreation and dissipation rather than for efficiency. The statistics of the National Employment Exchange endowed by J. P. Morgan, John D. Rockefeller, and others, show that many of our young men are given just enough education to give them a distaste for manual work, but not enough to make them competent office men, superintendents, managers and the like."

"I ordered a pair of molding machines, and will put them in for the moral effect," replied Duxbury. "There were a lot of western exhibits."

"Those western fellows must be a progressive lot," ventured Adams.

"Yes, they shoveled and rammed with the molding machines, and manipulated other machinery like lightning, and all the time just bursting themselves trying to hold their breath and appear unconcerned, just as if they were resting in a hammock. Don't buy a molding machine just as a companion for idle hours."

# The Foundry and Available Pig Iron Supply*

By A I Findley

FOUNDRYMEN have been raising the question, as various changes in the blast furnace industry have been reported from time to time, how these are likely to affect the supply and the price of foundry iron. The absorption by steel companies of three merchant furnaces in the central west—one near Pittsburgh and the others in the Youngstown district—and the expected acquisition of another Mahoning valley furnace by a steel company, prompted one of these inquiries. It came from a Pittsburgh foundryman, who has been for two terms president of the American Foundrymen's Association. He had noticed similar absorptions in eastern Pennsylvania, one steel company taking over two furnaces which had long produced foundry as well as basic iron, while a second steel company acquired three furnaces in the Lehigh valley which had for many years marketed a considerable part of their output among eastern Pennsylvania and New England foundries. Another loss from the merchant furnace ranks, in comparatively recent time, came through the purchase of a Shenango valley merchant furnace by an ingot mold manufacturer operating in the same city.

The questions foundrymen were interested in having answered were whether these disappearances from the merchant furnace list are signs of a movement which is likely to go farther and what the ultimate effect would be on the market for foundry pig iron. In the same connection other changes in the manufacturing and marketing of foundry pig iron in recent years are attracting attention suggesting that all developments bearing on the supply of the foundryman's chief raw material might well be considered at the same time. Naturally the year 1907 is one from which reckonings are taken in any inquiry into recent economic changes, and our discussion will have to do, therefore, with the course of the foundry pig iron industry in the past five years, and the indications it gives as to the future.

*Presented at the Buffalo meeting of the American Foundrymen's Association.

### *Precarious Position of Merchant Furnaces*

It is not strange that foundrymen in districts immediately tributary to the Mahoning and Shenango valleys should be interested in the merchant furnaceman's status. For 15 years it has been precarious. With regularity in that period the passing of the merchant furnaces as a factor in the iron trade of the valleys has been predicted. In years more recent the steel companies have built more and more blast furnaces and as their buying of pig iron in the market has come at rarer intervals, it has been made plain that the merchant furnace producing steel-making iron would find its field of operations constantly narrowing. But no harm could come to the foundryman in all this. Its tendency would be to increase the competition in foundry pig iron, except as new open-hearth steel plants of smaller size were raised up to take the steel-making iron no longer wanted by the large companies.

If we answer our foundryman's question in the light of new blast furnace construction in the past five years, we shall find that any absorptions of merchant furnaces have been far overbalanced by the building of furnaces to make pig iron for the market. Beginning with 1907, the record of additions to merchant furnace capacity, with the estimated yearly output is as follows:

In 1907—Toledo No. 2, Josephine No. 1, Federal No. 1, Mayville B and Perry; 545,000 gross tons a year.

In 1908—Vanderbilt No. 2, Wickwire X (70 per cent merchant), Miami, Jisco and Ironton; 355,000 tons a year.

In 1909—Federal No. 2 and Cleveland No. 2; 255,000 tons a year.

In 1910—River No. 1, Wickwire Y and Zug Island No. 2; 350,000 tons a year.

In 1911—River No. 2 and Josephine No. 2 completed, but not blown-in until 1912; 250,000 tons a year.

In 1912—Two Iroquois and two Rogers-Brown (Buffalo); 510,000 tons a year.

Here is a total of 2,265,000 tons of foundry pig iron capacity added since Jan. 1, 1907, in a period marked, between the panic of October, 1907, and the early summer of 1912, by a demand for foundry products materially less than the average for the three years preceding the panic. Not all of this more than two million tons capacity will necessarily be burdened for foundry iron all the time. Some of it will run on basic iron at times, but it is all owned by companies engaged in the foundry iron trade and, therefore, represents potential, and very largely actual, foundry iron production.

It is of interest to note in what districts this expansion in capacity has been most marked. Nearly 75 per cent of it, or 1,665,000 tons a year, is located in lake cities—South Chicago, Detroit, Toledo, Cleveland, Erie, Buffalo—where lake ores are unloaded directly

into furnace yards and hence where cost of manufacture is low. A further significant fact is that the builders of all of this 75 per cent of the foundry iron capacity added in the past five and one-half years have their own ore supply, either by direct ownership or through connected ore interests, and some of them have coke connections. These furnaces, therefore, will be making iron under conditions which would close down many other stacks, as some of them demonstrated in the trying years last past. In fact, if the prices at which some of them sold in the closing months of 1911 are a criterion, there is no probable degree of distress in the foundry trade to which they will not be able to accommodate themselves.

That there has been no such expansion in the foundry capacity of the country in the past five years as would call for all the product of these 19 new furnaces, scarcely need be said. It is almost equally obvious that some of these furnaces will market their iron at times by displacing the product of furnaces having higher costs. Something of the course of the foundry industry in the past 10 years may be gathered from the statistics of production of foundry iron (including ferrosilicon) and malleable Bessemer which are as follows, as given in the reports of the American Iron and Steel Association:

*Production of Foundry and Malleable Bessemer*

| | Gross tons | | Gross tons |
|---|---|---|---|
| 1902 | 4,162,734 | 1907 | 6,071,499 |
| 1903 | 4,882,804 | 1908 | 4,052,579 |
| 1904 | 4,090,758 | 1909 | 5,980,463 |
| 1905 | 5,393,274 | 1910 | 6,103,570 |
| 1906 | 5,472,712 | 1911 | 5,081,473 |

There were imports of a few hundred thousand tons in 1902 and 1903 and another import movement amounting altogether to about 500,000 tons in 1906 and 1907. But there was also some accumulation at home in 1907 and a more marked home accumulation in 1910. It is probable, therefore, that the home consumption of foundry and malleable grades (Bessemer, basic and low phosphorus iron melted by steel foundries are not included above) was under 6,000,000 tons in 1907, one of the two high years in the table, and considerably under that figure in 1910. Last year, in spite of the known reduction of foundry pig iron stocks, the consumption was probably not much above the average for the three lean years preceding, which was so conspicuously reduced by the low rate of 1908. Conditions were thus ripe for the forward movement of which there are so many proofs just now.

The competitive situation in foundry iron in northern markets has long been thought of as turning on the supply of southern pig iron. Southern foundry iron has been looked upon as a necessity in certain percentages and for certain uses. More than that, the possibility that on the score of cheapness it would at times displace northern irons in certain districts has been held up as a check on prices, not only of northern foundry irons, but of the lake ores entering into them. The course of the market in the past five or six years has some suggestion on these points. But first it will be of interest to note the contribution of Alabama and Tennessee to the production of foundry iron shown in the foregoing table. For the same 10 years the figures are as follows, no account being taken of basic or forge irons:

*Production of Foundry Iron, Gross Tons*

| | Alabama. | Tennessee. | Total. |
|---|---|---|---|
| 1902 | 1,044,874 | 328,975 | 1,373,849 |
| 1903 | 1,194,556 | 350,966 | 1,545,522 |
| 1904 | 1,085,935 | 253,185 | 1,321,120 |
| 1905 | 1,094,149 | 311,880 | 1,406,029 |
| 1906 | 1,117,262 | 376,722 | 1,493,984 |
| 1907 | 1,113,340 | 337,737 | 1,451,077 |
| 1908 | 884,920 | 255,945 | 1,140,865 |
| 1909 | 1,280,798 | 291,162 | 1,571,960 |
| 1910 | 1,200,346 | 308,749 | 1,509,095 |
| 1911 | 1,240,808 | 275,091 | 1,515,899 |

While Alabama and Tennessee produced 29.5 per cent of the total in the first five years of the 10, they produced but 26 per cent in the second half of the period. It is significant that in the list of 21 new furnaces, the south contributed only one, and that of 75,000 tons yearly capacity, or 3-1/3 per cent of the total. At the same time the south is using more of its foundry iron in its own foundries. Capacity for machinery castings probably has not increased measurably in the south since the panic, but a large radiator plant has been built that will draw most of its iron from the south, a similar plant in Alabama is about to be built and a large southern soil pipe foundry has been completed. Cast iron pipe works are the main consumers. Some Alabama furnaces are now disposing of about one-third of their foundry iron product south of the Ohio river. It is true that Tennessee furnaces have few closely contributary consumers; but the important fact is that southern foundry iron is a diminishing factor in the mixtures of northern foundries.

It has become increasingly evident that price is the determining factor in the marketing of southern irons. A high phosphorus content has brought a considerably higher price at times for southern iron from a northern stove plate or light gray iron foundry. But northern furnaces have also been meeting the demand for phosphorus. A marked development in the practice of some of those in the lake cities is the use of higher phosphorus ores, bringing the phosphorus in the pig up to 0.60 to 1 per cent and in the case of one iron up to 1.50. Lake Superior ores answering this purpose are not plentiful, but development in the Crystal Falls district of Michigan is adding to the supply, and in one case a high phosphorus ore from southern Ohio has been drawn upon by a lake front furnace.

It is good testimony to the better methods of mixing and melting foundrymen are mastering that they are now able to use, to a greater extent, than ever the iron that can be delivered the cheapest. In the period of unprofitable prices through which furnacemen have been passing the low quotations in such competitive markets as Chicago and the furnace centers on Lake Erie have alternated between southern and northern irons. In Chicago some years ago northern iron usually brought from 25 to 50 cents a ton higher than southern. In the recent depression the conditions have been reversed and northern iron in the Chicago market has undersold that from the south, a condition that still exists.

*Buying on Analysis*

Much as has been said about the practice of larger foundries of buying their pig iron on analysis, the extent to which classification by numbers has been discarded is probably not appreciated. When the foundryman buys by number he gives the seller a considerable leeway on silicon—50 points usually—and if this is stretched out to 75, the average buyer would be none the wiser. With close regulation of his mixture by analysis the foundryman is now drawing in the lines on silicon and specifying a desired analysis, so that in some cases sales turn on the matter of 0.25 per cent silicon. The recent increase in the use of silicon as the basis of purchases indicates that the time is not far away when pig iron numbers will be eliminated from transactions and the price determined by a specified content of silicon, with other elements exerting an influence on price where an unusual and special content of these is stipulated.

The whole foundry iron situation has been so dominated in the past three years by depressing influences, that one must not generalize too far concerning changes in foundry practice that have had their influence in that period. Aided by the extreme cheapness of basic pig iron, some of the steel foundries have made very low prices, to the displacement at times of forgings and malleable and perhaps gray iron castings; but time will be required to show whether the inroad is permanent. Malleable foundries, at the same time, have cheapened their mixture, due to the same cheapness of basic iron, buying off-basic,

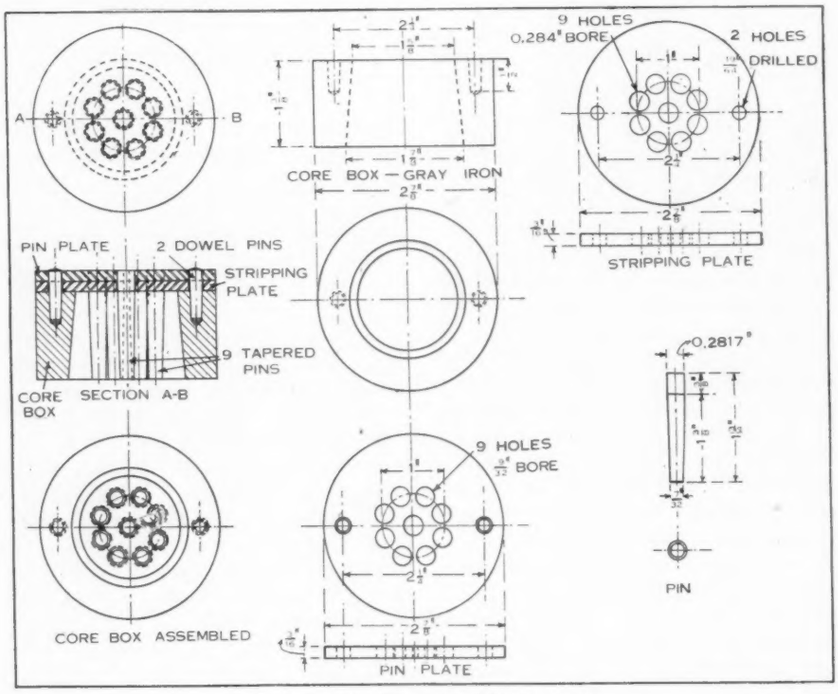
an iron in which the silicon was higher than steel works would accept. This competition from basic furnaces has affected the price of malleable Bessemer, which has at intervals been below its normal parity with No. 2 foundry iron.

*Increased Use of Charcoal Iron*

Some very good work has been done in the direction of giving charcoal iron a larger place in car wheel and special mixtures. There have been some results, and the demand upon the railroads for freight car wheels that will better stand the heavy service of recent years is helping the movement. But price is so controlling an influence in railroad buying that the low level of coke pig iron has held down the charcoal product, and much is yet to be done to secure recognition for it on the score of quality. In chilled work and for castings requiring a special selection of raw material, charcoal iron is making headway and the outlook has been sufficiently promising to encourage some addition to the capacity of Michigan charcoal furnaces in the past three years. Lately, Mayari pig iron, which owes its properties to a small content of nickel and chromium, has been offered as a component of chilled roll mixtures and for castings requiring special strength.

So far as the figures furnished permit of deductions, they indicate that foundry pig iron prices in 1911 showed a falling off from the level of 1907 quite equal to, and in some cases greater than, the shrinkage in prices of castings. The foundryman, with proper attention to his cupola, and with the development of economies in molding machine operation to which hard times furnish the spur, has apparently not fared as badly on the whole as the blast furnaceman.

What has been written as to the steady increase in foundry iron capacity in central western districts in the past five years is not intended to bear on the immediately future course of the market for foundry iron. In that problem a number of factors are involved which cannot be gone into here. But enough has been said to indicate that foundrymen have no reason for anxiety over anything that has happened thus far in the way of absorption of merchant blast furnaces. What has been pointed out as to the lessening of the supply of southern iron for sale in the north is of interest to northern foundrymen regularly depending on such iron for a part of their mixture. But the factor of first importance in the whole question of foundry iron supply and demand is the prodigious addition made in and since 1907 to the foundry iron capacity of the country. Of chief significance in that connection is the fact that in the lake cities, from Buffalo on the east to South Chicago on the west, such additions have brought the foundry capacity of these cities up to 3,000,000 tons a year. In other words, this cordon of 27 furnaces between the foot of Lake Michigan and the foot of Lake Erie now represents a capacity equal to half the consumption of foundry iron in the United States in the high record year. The question of supply, and generally speaking at a moderate level of prices, is therefore one about which foundrymen need have no early concern.




CORE BOX FOR STRAINER GATE

## A Simple Strainer Gate

The loss of castings due to slag and dirt inclusion in the metal is an ever-present source of annoyance in every foundry. To prevent dirty metal from entering the molds, many devices have been adopted from time to time, chief of these being the skim-gate. A gate which operates successfully in preventing the entrance of slag into the mold, is of the strainer type. It is simple and inexpensive in design and may be used to advantage in producing both large and small castings.

This gate is made by placing a dry sand strainer at the bottom of the sprue, immediately above the gate. This strainer contains a number of parallel, circular openings, sufficiently large in diameter to permit the iron to pass through without becoming chilled. These dry sand cores or strainers may be made by means of the corebox shown in the accompanying illustration, silica sand and linseed oil being employed in the proportion of 40 to 1.

The core box is made of cast iron and is provided with a sheet steel stripping plate and a top or pin plate. The latter, as shown in the illustration, is provided with a number of cold-rolled steel, taper pins. The top ends of the pins are machined to such a diameter that they may be driven into holes in the pin plates, flush with the surface of the latter. Both the pins and the dowel pins pass through holes in the stripping plate, the dowel pins fitting into sockets drilled in the top of the gray iron core box.

As shown, the interior of the core box is so tapered that the dry sand core or strainer will derive sufficient support from the green sand in the mold that it will not drop out when the cope is lifted from the pattern follow-board.

For castings weighing 500 pounds or less, a strainer having nine holes will suffice. For castings weighing between 500 and 1,000 pounds, it is advisable to add another ring of pins in the core box, thus making a total of 17 holes. For larger castings, the number of holes may be increased. The cores are usually made in large lots and are kept in stock, being delivered to the molder as they are needed.

# The Prevention of Accidents in Steel Foundries

*How the Workmen Are Safeguarded Against Injuries in the Plants of the American Steel Foundries*

By Guy W Nelson

A CLOSE observance of casualties reveals the fact that most accidents in manufacturing plants are attributable to one of three causes:

Accidents due to carelessness.

Accidents due to unforeseen circumstances, or accidents which happen through extraordinary coincidence of events.

Accidents incident to manufacture, or due to the inherent risk of industry.

It is unfortunate that there are no authentic statistics to show what the relative percentage of industrial casualties are with regard to those three causes, yet, I believe anyone who has given the subject close attention will agree that carelessness is to blame for at least one-half of the accidents which happen in manufacturing plants.

*Carelessness*

Carelessness is not only a fault of the workman, but also of the employer. Indifference on the part of the employer toward the matter of safety in the daily practice of the shop, or failure to provide machinery with adequate safeguards is, unquestionably, carelessness on the part of the employer, and is responsible for a startling number of casualties. On the other hand, failure of the workman to exercise proper care and precaution in his work, disregard for instructions and recklessness, which are characteristics of the average workman, likewise has caused many a tragedy.

Not only are accidents due to carelessness the most common, but they are, perhaps, also the most costly to the employer from the standpoint of liability. There is little, and in some states no defense whatever for an employer when an accident happens in his plant through carelessness. This is because such accidents are largely preventable and it can generally be shown that danger was apparent before the accident happened. Opinions differ a great deal as to just what parts of machinery are dangerous and what parts are not dangerous. Some manufacturers believe in safeguarding every gear, pulley, belt, cutter and moving part of a machine, while others believe it is necessary to safeguard only the parts which are most openly exposed.

The necessity, however, of eliminating the remote dangers as well as the apparent dangers of machinery, I believe, is plainly evidenced in the attitude so often taken by the courts in personal injury cases when dealing with accidents involving machinery. It is not unusual for the court to take the stand that "the accident would not have happened had the machine been properly safeguarded." The fact that a man was hurt while operating a machine is very often sufficient evidence to convince a court that the machine must have been improperly or insufficiently guarded or the man would not have been hurt. It must, of course, be admitted that this attitude is unjustified and unreasonable in a good many cases because of the fact that it never yet has been possible to set standards for the safeguarding of all the various machines used in the many different manufacturing plants today throughout the country.

SPECIAL APRON FOR GRINDERS OF IRON AND STEEL CASTINGS

*Familiarity, Etc.*

That familiarity breeds contempt is manifested by hundreds of workmen every day in the matter of safety. It is strange, but nevertheless true, that nothing short of a tragedy will awaken the mind of the average workman to the common dangers which surround him in a shop operating machinery. An employer's responsibility for his employe's safety does not end with the safeguarding of all dangerous machinery in his plant. He is also responsible if he fails to see to it that inexperienced employes receive proper instructions and warning regarding the dangers of their occupations, and for failure to make and enforce rules among his employes for the safe handling of work.

Leaving the question of justification entirely out of the subject, it would seem that the time is at hand for each employer to devote more of his time and attention to the work of accident prevention. The public demand for employers' liability and workman's compensation laws is spreading over the country very rapidly, and is making it imperative for the employer to protect his employes. The laws recently drafted in some states are very drastic, but no matter what plans may be adopted for handling accidents which have happened, the chief aim of every employer should be to protect himself and make every effort to prevent the occurrence of as many accidents as possible, providing payment or compensation for such only as cannot be prevented.

A persistent study of the causes of accidents which happen from time to time in any plant will develop ways and means of lessening the number. A record of every accident, describing the circumstances fully, should be kept by every manufacturer. Such a record, if kept up for a short period, will show just what the hazards of the industry are. Then, by process of elimination, it will be comparatively

easy to rid the plant of the most common hazards.

In May, 1910, the American Steel Foundries took up the study of accident prevention, and organized a department to carry on a safety campaign with the object in view of safeguarding all apparently dangerous machinery and equipment and the investigation of the causes of accidents in its various plants. During the past two years 3,150 recommendations have been made by the safety inspectors in charge of the work in each plant and to date, approximately 2,500 safeguards and appliances have been installed.

The scope of work has included not only the installation of safeguards on machinery, but also improvements in sanitation, ventilation, light and

CABINET DISPLAYING ACCESSORIES SOLD AT COST TO ITS EMPLOYES BY THE AMERICAN STEEL FOUNDRIES

an educational campaign among the employes for their general welfare. The results of the campaign have been very gratifying. The work of safeguarding the most dangerous machinery was taken up first. Exposed gears, belts, pulleys, clutches, set screws, counterweights, emery wheels, saws, etc., have been enclosed in steel plate and wire screen guards. Innovations such as leather gloves, leggings, grinders' aprons, goggles, molders' shoes, etc., have been introduced for the protection and safety of the workman. Dangerous practices of operation have been almost entirely eliminated. Sanitary lavatories have been built. Better natural and artificial light has been provided.

The educational campaign among the workmen has been conducted in various ways. Glass-covered bulletin boards have been placed in every department. They are used to post clippings from all the various newspapers throughout the country describing the circumstances of accidents in other plants as well as our own, photographs and drawings showing how accidents happen, also how they can be avoided, and merit statements each month comparing the accident records of the different departments. Danger and warning signs are displayed in all parts of the plants where danger exists. Rules and instructions are given the workmen by the foremen and are enforced through discipline. Cigars bearing a safety slogan are passed out monthly to the men in the departments having the least number of accidents. Free medical dispensaries have been established in each plant for the care of injured and sick employes. Workmen's safety committees are appointed regularly to inspect and investigate conditions in the plants and make recommendations or suggestions for improvements in the shops. Meetings of the department foremen are held frequently and the subject of safety is taken up and discussed with other matters of shop importance.

*Accidents From Unforeseen Causes*

Without detracting from the great value of safeguards, it is hardly necessary to state that not all accidents can be prevented by their use. Frequently, accidents occur from a cause which could not have been foreseen. While it is not fair to term such accidents preventable, still, the circumstances of the accident itself can very often be utilized to prevent its repetition. I recall such an accident which happened a short time ago, and which caused a man to be disabled for three or four months. The workman was a molder in one of our foundries. While finishing a mold weighing about 250 pounds, which was suspended from an air hoist 3 feet from the floor, the flask fell and broke the molder's ankle. Upon examining the air hoist it was discovered that a nut on the end of the piston rod inside of the cylinder had worked loose, and finally came off. The manufacturers of the air hoist had neglected to provide a cotter pin or similar device above the nut on the piston rod and as the cylinder had never been taken apart for repairs in our own shop this condition was never known to have existed until the accident occurred. This accident could not have been foreseen for the reason that the defective part of the machine was entirely hidden from view inside of the cylinder. However, the circumstances of the accident were utilized to prevent a similar occurrence. Every hoist in the shop was immediately overhauled and a cotter pin was placed above the nut on the piston rod of each machine.

*Grinders' Apron*

Probably the most difficult of all accidents to completely eliminate are the accidents incidental to manufacture, or the accidents which are inherent owing to the nature of the industry. Much can be done, however, to minimize this hazard as well as the others I have mentioned. An example of this is shown in an innovation called the grinders' apron, recently introduced by the American Steel Foundries. A good deal of trouble was experienced at one of the company's plants in getting men to grind heavy castings on high speed emery wheels. The men would quit after a few days' work at these wheels, complaining of pains and swelling in the lower abdominal regions. This was caused by the violent vibration and thumping of the castings against the abdomen. A steel-braided leather apron was designed by the safety inspector of the plant for the protection of these men, and simultaneously the difficulty experienced in hiring men to work in the grinding department ceased with the adoption of the apron. The apron is a very simple and inexpensive contrivance. It is made of two thicknesses of sole leather, stuffed with scrap leather findings, with the outside braided all over with steel rivets.

It is shaped to fit the contour of the body and is held in place with straps fitting over the shoulders.

The introduction of congress or molders' shoes is another innovation which, although not a new one by any means, is an accident saver of no little importance. Burns on the feet are very common in factory practice. A splash of molten metal on the upper part of a lace shoe is pretty nearly always bound to result in a serious burn, whereas if the congress shoe is worn by the workman the metal will roll off the shoe without burning through the leather. It is also very difficult and painful to remove a lace shoe from the foot in case of a very bad burn, when, on the other hand, a congress shoe can be very easily slipped off the foot.

The use of goggles to protect the eyes of men from steel chips while grinding castings cannot be too strongly urged in foundries. It is sometimes a difficult matter to get the workman to use goggles of his own accord, but this can generally be brought about by insistence on the part of the foreman.

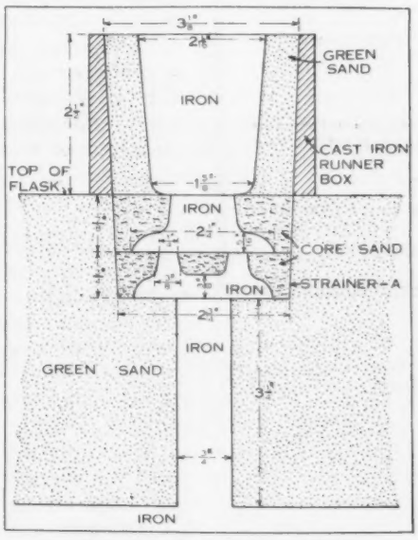
*Trivial Injuries Result Seriously*

An injury does not necessarily have to be serious to cause a workman to lose time. In almost any plant small accidents happen from time to time such as cuts, burns, callouses and scratches. Experience has shown that in a good many instances such trivial injuries develop into very serious infections and have even necessitated amputation. The use of leather or asbestos hand gloves will prevent many small injuries. The policy of the American Steel Foundries has been to supply its workmen through the company's stores department with all such necessary accessories as gloves, hand pads, goggles, molders' shoes, wooden-soled shoes, etc., at cost price. Display cabinets showing samples, together with signs advertising and recommending the use of these articles, are placed throughout the plants.

It is essential that a plant having a number of minor accidents be equipped with some facilities for administering first aid to the injured. The most satisfactory method is to have a small dispensary with a complete outfit of bandages, antiseptic salves, liniments, etc., located within the plant in charge of some responsible employe. Many trivial injuries can be successfully taken care of by the plant dispensary if taken in time and proper dressing applied before infection sets in.

Too much emphasis cannot be given the importance of educating the workmen to do all they can themselves to avoid accidents. Keeping the subject constantly alive in their minds is half the battle and no better means can be employed to this end, I believe, than the bulletin board, the danger sign and the personal safety equipment show case.

The work of accident prevention is not such a complicated problem as it would seem, although it is something which requires careful thought and eternal vigilance. Keeping a plant clean and orderly, the provision of ample room about machinery and equipment, regular inspection of machinery, tools and buildings, careful selection of workmen and their assignments to work for which they are not unsuited, the promulgation and enforcement of rules for safeguarding, not only will reduce the casualties of any plant, but also will aid in promoting efficiency and will stimulate economical operations.




THE GILVEAR SKIM GATE

## An Effective Skim Gate

In the accompanying illustration is shown a skim gate, designed by T. H. Gilvear, foundry superintendent of the Berlin Machine Works, Ltd., Hamilton, Ont. The gate is made in two sections from a core sand mixture and a third section, consisting of a cast iron runner box molded to form a pouring basin, is superimposed on the lower sections. The lower section of the gate, which is a strainer, ordinarily contains three holes through which the metal is strained into the mold and a gate of this size is sufficiently large for castings averaging 50 pounds in weight. However, this gate can be used for making castings weighing 400 pounds by increasing its size and adding to the number of openings through which the iron flows into the sprue of the mold. It will be noted, in the accompanying illustration, that the iron flows from the runner box into a gate having two openings into the strainer. It is claimed that any dirt contained in the iron, particularly in the first few drops poured, cannot penetrate the mold, as it is forced aside in the strainer by the following metal. In the foundry operated by the Berlin Machine Works, Ltd., several hundred of these gates are used daily and the number of bad castings resulting from dirty metal has been materially reduced.

## Wash for Steel Molds

A patent for a wash or coating for steel molds has been issued to Charles H. Haslett and A. A. Mentzer, of Pittsburgh. It consists of alum dissolved in water in the proportions of 1 of alum to 60 to 100 parts of water. This coating is employed when the sand contains a sufficient amount of binder and in the absence of a proper binding material glutrin is employed in the proportion of 6 parts of glutrin to 1 of alum. When the latter composition is used, the material is boiled for about an hour and after it has cooled, it is ready for use. After the mold has been finished, the surface is coated with the alum and water solution, after which it is baked or skin-dried. The baking of the mold causes the surface to become hard and the depth to which the hardness extends depends on the length of time the mold is baked. To obtain the desired results, however, it is not necessary to dry or bake the mold, as excellent results have been obtained with green sand molds. This hardened surface does not destroy the porosity of the molds, but serves to prevent sweating or the running of the molten metal through the wall of the mold during the pouring operation. If the facing sand is not primarily treated with glutrin, the composition containing the glutrin is employed, and, it is claimed, with equally satisfactory results. One feature of this composition in either of its forms is that while the face of the mold becomes exceedingly hard and difficult to destroy or affect when the mold has been baked, the application of either the solution or water immediately destroys this surface or face and leaves the sand in condition for further use. It is stated that the more frequently the sand treated in this manner is employed for making molds, the more satisfactory will be the results.

# THE FOUNDRY

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## Contents


MAKING A PATTERN FOR A PARSONS STEAM TURBINE..... 499
HOW TO MELT IRON TO OBTAIN THE BEST RESULTS..... 503
TESTS OF MONEL METAL ..... 505
A FOUNDRY COST SYSTEM THAT PRODUCES RESULTS..... 507
STEEL ROLL DIFFICULTIES ..... 510
MAKING PATTERNS FOR MACHINE-MOLDED GEARS—I..... 511
THE USE OF GAS LAMPS ..... 514
EQUIPMENT AND MANAGEMENT OF NICKEL BATHS—I..... 515
ORIGIN OF SHOT IN CAST IRON..... 516
NICKEL-PLATING STEEL TUBES ..... 517
SNOW FLAKE FINISH ..... 517
REFINISHING STEEL KNIVES ..... 517
ELECTRIC CLEANING SOLUTION ..... 518
USE OF COMPRESSED AIR IN FOUNDRY PRACTICE..... 519
ALLOY NOMENCLATURES ..... 522
MAKING BASIC OPEN-HEARTH STEEL FOR CASTINGS..... 523
DIFFICULTIES IN MAKING SOUND CASTINGS..... 524
PRODUCING COLORS BY ELECTRO-DEPOSITION ..... 524
COPPER ALLOYS FOR MOTOR CAR SERVICE ..... 525
CHEAP WHITE METAL ALLOY ..... 528
SHRINKAGE DIFFICULTIES ..... 528
YELLOW BRASS ..... 528
BELL METAL MIXTURES ..... 528
SCRAP WIRE VERSUS INGOT COPPER..... 529
SHOTTING COPPER AND NICKEL ..... 529
DEFECTIVE CIRCULAR BRONZE PLATE ..... 529
HOW TO CAST LEAD..... 529
SEGREGATION OF LEAD..... 529
HISTORY OF THE ASSOCIATED FOUNDRY FOREMEN..... 530
THE BUFFALO METAL FEST FROM TWO ANGLES..... 531
THE FOUNDRY AND AVAILABLE PIG IRON SUPPLY..... 532
A SIMPLE STRAINER GATE ..... 534
THE PREVENTION OF ACCIDENTS IN STEEL FOUNDRIES..... 535
AN EFFECTIVE SKIM GATE..... 537
WASH FOR STEEL MOLDS ..... 537
ELECTRIC FURNACE FOR FOUNDRY WORK..... 538
TRADE OUTLOOK ..... 538
ANNUAL MEETING OF EXHIBITION COMPANY..... 539
WATER IN THE CUPOLA BLAST..... 539
DEATH OF JAMES MILLER JACK..... 539
TUOHY INTERCHANGEABLE FLASK ..... 540
PERSONAL ..... 540
BOOK REVIEW ..... 540
A NEW 24-INCH LIFTING MAGNET..... 541
TRADE PUBLICATIONS ..... 541
GENERAL INDUSTRIAL NOTES ..... 542


## *Electric Furnace for Foundry Work*

WHILE the electric furnace is a comparative novelty in American casting shops, foundrymen in England, Germany and France have been quick to appreciate the advantages of this practice and the number of installations abroad is far in excess of the total of electric refining units in this country. Recently, however, there has been an awakening, and the casting manufacturers of the United States are carefully investigating the merits of the various types of furnaces built. In addition to the small number of plants which are now in operation in this country, numerous experimental installations have been made and it is probable that this method of refining will be applied to malleable iron as well as steel. No definite information is yet available with reference to the substitution of the electric for the air furnace, but the trials under way promise interesting developments and may lead to the replacement of the archaic, reverberatory melting medium. For economy of operation, the cupola, notwithstanding its crudities, is the peer of all furnaces, and until electric power can be obtained at a much lower cost than prevails today, the cupola will successfully resist the attacks of the promoters of the electric refining method.

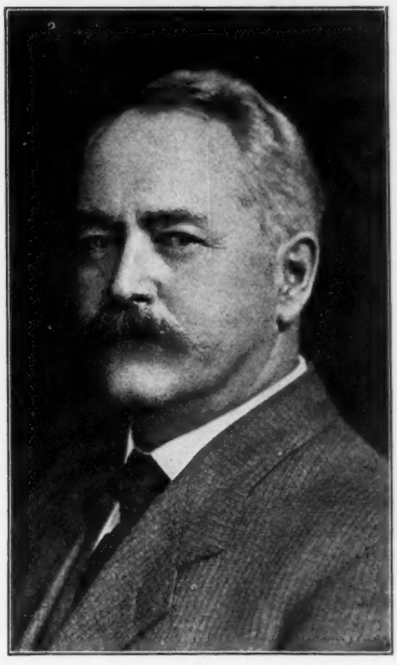
## *Trade Outlook*

ALL branches of the foundry industry are sharing in the prevailing prosperity and casting shops throughout the country are operating at capacity. The demand for castings is greatly in excess of the output and many plants are unable to make deliveries on new orders in less than three months. To some extent, the raw material shortage has curtailed the output of gray iron and aluminum plants and there is little indication of an increased supply in the immediate future. Some improvement is reported in the labor situation and the number of available men undoubtedly will increase with the advent of cold weather. An encouraging feature of the situation is the increased demand for castings for heavy machinery and equipment. Foundries, particularly in the New England and Cincinnati districts, which specialize in machinery work, are rapidly increasing their melt. Steel and malleable shops are busily engaged on railroad work. Owing to the scarcity of aluminum, which is growing more pronounced daily, builders of automobiles are experiencing considerable difficulty in obtaining castings. The present aluminum output is entirely inadequate and notwithstanding the heavy importations from England and Germany, many shops are compelled to depend upon the scrap supply. Last year many motor car parts were made of malleable, the low prices prevailing at that time having proved particularly inviting. However, as the railroad tonnage increased, there was a corresponding decline in the output of malleable parts for motor cars and the manufacturers again were forced to place their business with the aluminum foundries. Foundry grades of pig iron continue scarce and producers are not anxious to book orders for forward deliveries at present prices, believing that higher quotations will prevail next year. In the leading centers No. 2 foundry iron is quoted as follows: Chicago, $18; southern Ohio, Cincinnati, $17.95 to $18.20; Birmingham, $14 to $14.50; Pittsburgh, $18.40; Cleveland, $17.50 to $18, and Philadelphia, $18 to $18.25. Lake Superior charcoal is quoted at $18.75, Chicago, and basic, $18 to $18.25, Philadelphia, and $17.15 to $17.40, Pittsburgh.

## Annual Meeting of Exhibition Co.

The annual meeting of the Foundry & Machine Exhibition Co. was held in Pittsburgh, Monday, Oct. 28. Secretary C. E. Hoyt reported that there was a total of 108 exhibits at the Buffalo show, as compared with 120 at Pittsburgh in 1911. This decline, however, is attributed largely to the number of local exhibits at Pittsburgh, which totaled 21, as compared with 10 at Buffalo. The total number of square feet occupied at Pittsburgh was 34,650 against 29,131 at Buffalo. The report of the treasurer showed the total income for permits, gate receipts and space was $2,103.05 less than at Pittsburgh.

A cash dividend of 15 per cent was



F. N. PERKINS,
President, Foundry & Machine Exhibition Co.

declared on space rented to all exhibitors who have taken part in these exhibits for two consecutive years and all first year exhibitors have been notified that a reserve fund equal to 15 per cent of the amount paid by them for space rental has been set aside to be paid to them if they become exhibitors in 1913. It also was decided to contribute $500 to the work of the American Foundrymen's Association and $250 to the work of the American Institute of Metals.

Officers for the ensuing year were elected as follows: President, F. N. Perkins, Arcade Mfg. Co., Freeport, Ill.; vice president, R. S. Buch, R. S. Buch's Sons Co., Elizabethtown, Pa.; treasurer, J. S. McCormick, J. S. McCormick Co., Pittsburgh, and secretary, C. E. Hoyt, Lewis Institute, Chicago.

Directors were elected as follows: Wilfred Lewis, Tabor Mfg. Co., Philadelphia; George R. Rayner, Carborundum Co., Niagara Falls, N. Y.; E. H. Mumford, Mumford Molding Machine Co., New York City; A. M. Frauenheim, Herman Pneumatic Machine Co., Zelienople, Pa.; Henry A. Pridmore, Henry E. Pridmore, Chicago; H. R. Atwater, Osborn Mfg. Co., Cleveland; Edward A. Pridmore, International Molding Machine Co., Chicago; J. W. Campbell, Cleveland Wire Spring Co., Cleveland; F. N. Perkins; R. S. Buch; J. S. McCormick and C. E. Hoyt.

The board of managing directors is constituted as follows: F. N. Perkins, R. S. Buch, J. S. McCormick, George R. Rayner and C. E. Hoyt.

A joint meeting of the executive committees of the American Foundrymen's Association, the American Institute of Metals and the managing board of the Foundry & Machine Exhibition Co., will be held in Chicago, Dec. 3, for the purpose of deciding the time and place of the 1913 conventions and exhibit.

## Water in the Cupola Blast

*By W. J. Keep*

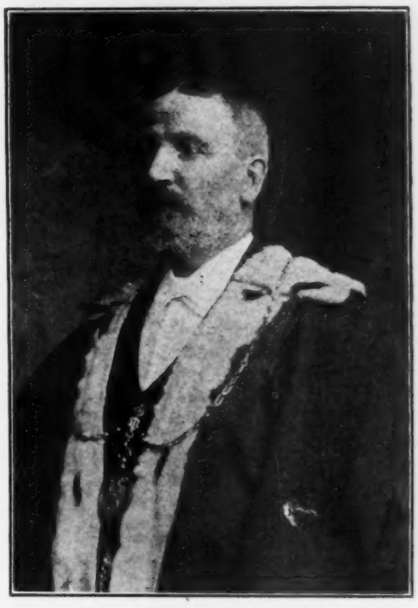
*Question*:—Recently a severe explosion occurred in our cupola and upon its repetition a few days later we found it was caused by water which was blown into the tuyeres when the blast was put on. Can you assign any cause for this and inform us how to prevent its recurrence?

*Answer*:—I had a similar experience several years ago. In our foundry our blast pipe is of considerable length and does not run on a continuous level and as a result, water, from condensation, accumulated in some parts of the pipe. When the blast was put on, the water was carried into the wind box and into the tuyeres, probably in a body or it may have been in the form of a heavy spray. We remedied the trouble immediately. The blast pipe was 18 inches in diameter and at a point about 25 feet from the cupola we built a box, 6 feet long, 3 feet deep and 18 inches wide, with the upper ends flanged around the pipe. The bottom of the pipe at this point was perforated so that any water that might accumulate would drop into the box. In addition to cementing the joints, the box was held in position by heavy straps. A valve was attached to the box and at times considerable water was discharged. It is evident to us that steam accumulated in the blast pipe when the bottom was dropped the previous day and when the blast was put on for the next day's heat, the water was forced into the cupola.

## Death of James Miller Jack

After a long and active life, crowned with success, James Miller Jack, general secretary of the Associated Iron Molders of Scotland, died at his home in Ayr, Scotland, on Sept. 27. Mr. Jack was one of the oldest officials, in point of service, in the British trade union movement, having become a member of the organization in which he was to take a leading part as a young man of 20, and 12 years later he was elected general secretary, a position which he held continuously for 33 years. When he assumed the office, the organization was bankrupt, but at the time of his death it was the wealthiest trade union, per capita, in existence.

In addition to his trade union labors, he took an active part in



JAMES MILLER JACK,
Late Secretary of the Associated Iron Molders of Scotland

public affairs, particularly in that movement which made Glasgow one of the leading cities of the world in the extent of municipally-owned and operated public and semi-public utilities. For 10 years he was a prominent member of the Glasgow town council, serving also two years as magistrate for the city and later he became justice of the peace, an office of high honor, which occupies a far more important position than the office of similar name in this country. In 1905, Mr. Jack made a trip to this country and one result of his visit was an agreement between the Associated Iron Molders of Scotland and the International Molders' Union of North America, which was the first of its kind entered into with any of the molders' unions in Europe. His gift of executive ability was excep-

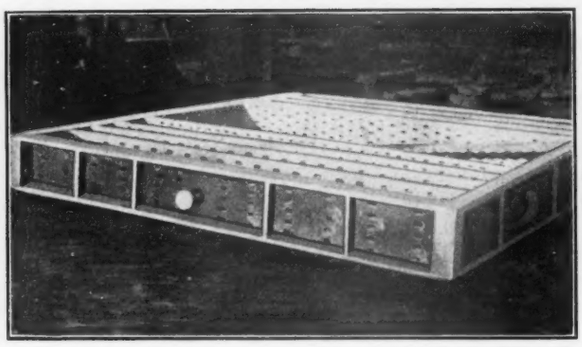


FIG. 1—A VIEW OF THE TUOHY ADJUSTABLE FLASK ASSEMBLED

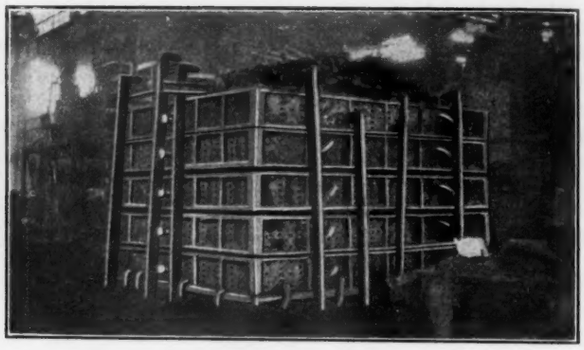


FIG. 2—FIFTEEN TONS OF STEEL WERE POURED INTO THIS FLASK; NEITHER BOLTS NOR RIVETS WERE USED TO HOLD THE FLASK TOGETHER

tional, and his unselfish interest in the welfare of his fellow workmen unquestioned.

## Tuohy Interchangeable Flask

The flask problem is a serious one for any foundry and particularly so for the jobbing shop. The amount of money which can be tied up in a moderate stock of ordinary wood or iron flasks is surprising and in addition a large storage space is necessary. To obviate these disadvantages, John Tuohy, of Pittsburgh, Contra Costa county, California, has invented a boltless, adjustable flask which has a number of interesting features.

The Tuohy flask consists of a series of cast iron side and end bars provided with tongue and groove connections so that they may be factened firmly together. A set of these bars is illustrated in Fig. 3 and an assembled flask is shown in Fig. 1. Included in this equipment are a number of interchangeable cope bars similar to those illustrated at *A*, Fig. 3. The tongues, cut in the ends of the cope bars, fit through slots in the sides of the flask, thus holding the bars securely. The cape bars may be used in connection with wood flasks if desired.

The interchangeable side bars, it is claimed, can be combined so as to make up any size flask from 24 inches square upward, advancing in width or length in steps of 6 inches. In order to securely fasten the flasks together at the corners, wedges are used in addition to the tongue and groove connections. No bolts or rivets are employed and a hammer is the only tool necessary to assemble the parts or knock them down.

It is claimed that the built-up flask is as rigid as a good bolted flask. The cope bars can be raised or lowered in the flask to fit the pattern and they can also be placed lengthwise or crosswise. Short bars can be inserted between the larger ones. In other words the most complicated system of barring can be built up. It is claimed that the expense for flask shop labor and material can be reduced from 60 to 75 per cent where interchangeable flasks are substituted for those of the solid type. The flask parts, bars and wedges, are unmachined, rough castings and are, therefore, made at the lowest possible initial cost.

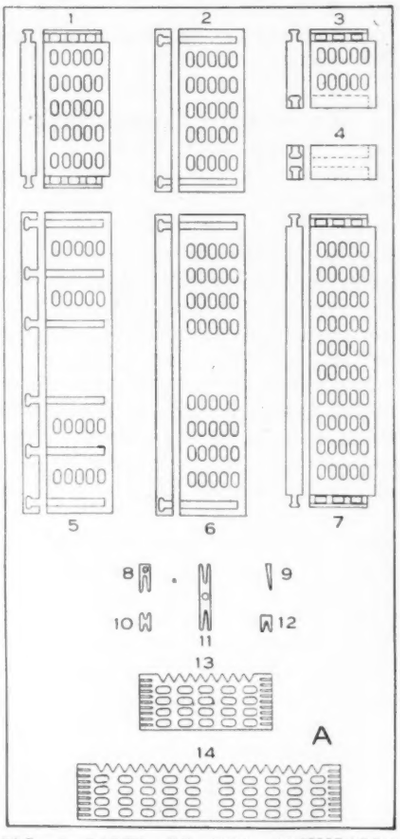



FIG. 3—PARTS OF THE ADJUSTABLE FLASK

The various flask parts, numerically indicated in Fig. 3, follow: 1, short flask side; 2, short flask end; 3 and 4, short flask inserts; 5, multiple flask end; 6, long flask end; 7, long flask side; 8, flask bar finger wedge; 9, flask wedge; 10, 11 and 12, types of flask bar finger wedges; 13, short flask bar, and 14, long flask bar.

## Personal

**Peter Hott,** formerly superintendent of the foundry operated by the C. & G. Cooper Co., Mt. Vernon, O., has resigned.

**J. E. Fisher,** formerly superintendent of the plant of the Beaver Dam Malleable Co., Beaver Dam, Wis., has been appointed superintendent of the Beaver Dam Foundry Co., of that place.

## Book Reviews

**Annual Statistical Report of the American Iron and Steel Association for 1911**—Part 2; 63 pages, published by the American Iron and Steel Association, Philadelphia. Part 1 and Part 2 of this report will be furnished by THE FOUNDRY, Cleveland, postpaid, for $5.00.

Part 2 of this report is devoted to the statistics of the production of plates and sheets, black plates for tinning, nail plates, merchant bars, skelp tin plates, cut and wire nails, miscellaneous rolled iron and steel, etc., and foreign iron and steel, iron ore and coal. The domestic statistics complete in detail all the information contained usually in the annual reports issued by the American Iron and Steel Association. The statistics of foreign trade are exceedingly comprehensive and include a study of the iron and steel, iron ore and coal industries of many foreign nations.

* * *

**Notes On Foundry Practice,** by J. J. Morgan; 108, 4¾ x 7¼-inch pages, illustrated; published by the J. B. Lippincott Co., Philadelphia, and furnished by THE FOUNDRY for $1.00 net.

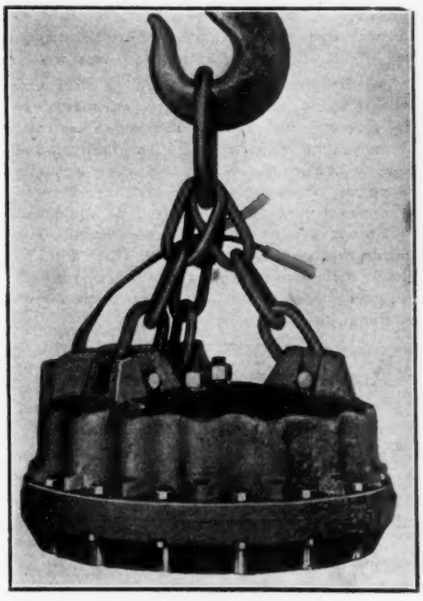
This book, to a large extent, is a compilation of published data on foundry practice and the work barely measures up to the intentions of the author, who states that it was designed to contain nothing more than a general description of the methods of founding. It was his purpose to present condensed and reliable information as to the materials used and

the methods followed, more particularly in iron founding and more briefly in steel, brass, bronze and phosphor bronze casting. As the work is written from an English viewpoint, American practice receives little consideration. The cupolas shown are of the English type and are not used in this country. The designs for the coke-hole brass melting furnaces represent construction by no means modern. The chapter on foundry tools is elementary.

* * *

**Cast Iron;** by W. H. Hatfield; 249, 6 x 9-inch pages; published by Chas. Griffin & Co., Ltd., London, and furnished by THE FOUNDRY for $3.50, net.

The results of many researches on the nature and properties of cast iron and the scientific principles underlying their manufacture are combined in this work. Much of the subject matter is the result of the author's own investigations and covers many years of experiment. The work opens with a discussion of the iron-carbon alloys and cast iron from the standpoint of the equilibrium diagram and the succeeding chapters deal with the influence of other constituents such as silicon, phosphorus, sulphur, manganese and the rarer elements. The remainder of the volume is devoted to a consideration of the influences incidental to the modes of manufacture, such as casting temperature, shrinkage and contraction and heat treatment generally. Many of the researches described consist of the work of eminent metallurgists and the author has endeavored to make a fair presentation of their views. The work is well illustrated and contains a brief glossary of the more important terms now current in metallurgical literature. With few exceptions the definitions are those recommended by the nomenclature committee of the British Iron & Steel Institute.



LIFTING MAGNET FOR HANDLING CASTINGS, SKULL CRACKERS, ETC.

## A New, 24-Inch Lifting Magnet

For various classes of work, such as handling light finished parts, castings, etc., and for lifting skull crackers for breaking scrap and skulls, a small lifting magnet can be used to advantage. For this reason the Cutler-Hammer Clutch Co., Milwaukee, has added a standard, 24-inch, circular type lifting magnet to its line. This magnet is built as strong and waterproof as those of larger size and is, in fact, a development of a type recently furnished for sub-marine service. The magnet shown in the accompanying illustration is provided with a special pole shoe for handling 24-inch and 36-inch skull crackers. The terminals of the magnet coil are permanently insulated. The net weight of this magnet is only 750 pounds and has a capacity for lifting a skull cracker 10 times its weight.

---

The firm name of the Industrial Car Co., West Park, Cleveland, has been changed to the Electric Locomotive & Car Co. to emphasize the electrical branch of this company's business. J. P. Copland, general manager, is in charge of this line of work. The company builds electric locomotives and all types of industrial cars.

# Trade Publications

FLASKS.—A catalog, containing 100 pages, issued by the Western Tool & Mfg. Co., Springfield, O., is devoted to the extensive line of foundry equipment made by this company, which includes portable snap-flask molding benches, various styles of snap flasks, steel slip jackets, wheelbarrows, shop trucks of all kinds, metal furniture, etc.

SMOOTH-ON CEMENT.—The Smooth-On Mfg. Co. Jersey, City, N. J., has issued a 40-page, illustrated booklet, in which are shown many instances of the successful use of the company's iron cement, in patching and waterproofing concrete structures of various kinds. These include cracks in concrete floors, engine pits, etc. The cement also is applicable to iron materials.

PATTERN SHOP AND FOUNDRY SUPPLIES.—In a 32-page catalog, issued recently by the Shanafelt Mfg. Co., Canton, O., its extensive line of foundry and pattern shop supplies is illustrated and described. The various products shown are manufactured by this company and include leather and wood fillet, rapping plates, wood dowels, pattern letters, chaplets of various types, snap flasks, brushes, etc.

CORE ROOM EQUIPMENT.—Five pamphlets, devoted to core room equipment, have been issued by the Wadsworth Core Machine & Equipment Co., Akron, O. The equipment discussed in these pamphlets follows: Vertical jar-ramming, core-forming machine, Wadsworth core machine, sand mixing machines, core cutting-off and coning machines, standard core prints, core testing apparatus and the Wadsworth-Detroit jar-ram, roll-over, box-lifting, core-making machine.

SANDS, CLAYS AND GRAVELS.—The Whitehead Brothers Co., Providence, R. I., has sent out a 16-page illustrated catalog, describing its different grades of sands, clays and gravels. These include: Albany and North River, Jersey and Steel, Lumberton molding sands; Jersey and Wareham fire sands and Jersey clay and kaolin; cupola daubing material; special clays; sticky silica sand; Millville and Jersey gravels; sand blast sand; Providence river core sand and others. Another catalog contains 16 pages with illustrations descriptive of the company's stove-plate sand, for which is claimed great cohesiveness, permeability and durability.

FOUNDRY CRANES AND EQUIPMENT.—The varied line of equipment and cranes for foundry use, built by the Whiting Foundry Equipment Co., Harvey, Ill., is illustrated and described in a 40-page catalog recently issued. The types of cranes shown include a gantry equipped with a lifting magnet, stock yard travelers, traveling cranes for handling material in foundries, hand travelers, wall bracket cranes, jib cranes, air hoists, overhead trolley systems, etc. Cupolas, cupola charging machines and other foundry melting department equipment are shown, as well as core ovens, core cars, etc., for the core room. An extensive line of ladles also is shown, as well as cars, trucks, turntables, tumbling mills, brass furnaces, sand sifters, steel converters, malleable furnaces, etc.

JAR-RAMMING MOLDING MACHINES.—A handsomely-illustrated catalog, devoted to its extenisve line of jar-ramming molding machines, has been issued by the Herman Pneumatic Machine Co., Zelienople, Pa. In addition to the plain type of jarring machine, a combination jar-ramming, squeezer, stripping plate machine is shown. Numerous views of machines are included in operation in various foundries and a number of intricate castings are shown. The plain jar-ramming machine also is adapted to ramming cores, as well as molds.

# General Industrial Notes

The Oliver Chilled Plow Co., South Bend, Ind., is installing a converter for the manufacture of steel castings.

The Enterprise Foundry Co. is remodeling its shop on Nixon and Manhattan streets, Pittsburgh.

The Muskegon Steel Castings Co. Muskegon, Mich., has been reorganized as the Western Michigan Steel Foundry Co., by William E. Jeannot, of Muskegon.

The new plant of the Roeller Foundry Co., Bay City, Mich., has been placed in operation and will engage in the manufacture of gray iron, brass and aluminum castings.

The Canadian Car & Foundry Co. Montreal, has taken over the Pratt & Letchworth Co., Brantford, Ont., manufacturer of steel castings. The plant will be enlarged.

Frank Little, successor to Little & Kline, Athens, Pa., who is operating a small iron foundry, expects to move soon and to equip his new shop for the manufacture of brass and aluminum castings.

The Jackson Ornamental Iron & Bronze Works, Jackson, Tenn., is building a new foundry. A cupola has been purchased, but a traveling crane and other equipment will be required.

The Eastern Malleable Iron Co. has been organized in Naugatuck, Conn., with a capitalization of $10,000,000, to be consolidated under one management located in Bridgeport, Naugatuck and New Britain, Conn., Troy, N. Y., and Wilmington, Del.

Brennan & Smythe, 2284 Scranton road, Cleveland, contemplate the installation of a converter for the manufacture of steel. This company now operates a number of crucible furnaces and is engaged in the manufacture of crucible steel castings.

The Alabama Pipe & Foundry Co., Anniston, Ala., advises that it will not erect a new foundry, as reported. It has purchased real estate and buildings formerly used for foundry purposes and will equip them for the manufacture of soil pipe.

The Tower Grove Foundry Co. St. Louis, is building a 60 x 71-foot addition to its foundry. A 10-ton electric crane will be installed, and the capacity of the plant will be increased to about 30 tons of chilled and gray iron castings per day.

The Electric Utilities Co., Ltd., Toronto, is completing a plant at New Hamburg, Ont., to manufacture telephones, telephone appliances. small motors, fans and electrical utilities. The works will include a brass foundry, iron foundry, and electro-plating and wood-working departments.

The Quigley Furnace & Foundry Co., Springfield, Mass., is building a foundry for the manufacture of high grade iron castings, including high pressure castings, special metal for annealing pots, air furnace iron, etc., and in addition will build annealing, melting and hardening furnaces, to be heated with pulverized coal, crude oil, or otherwise. The foundry building will be 250 x 350 feet, and the daily capacity will be 50 tons. It is expected the plant will be completed by Jan. 1. W. S. Quigley is vice president of the new company.

The Canadian plant of the Mueller Mfg. Co., Decatur, Ill., which is being built at Sarnia, Ont., shortly will be placed in operation. The Canadian company is known as the H. Mueller Mfg. Co., Ltd., and the officers follow: O. B. Mueller, president and general manager; C. G. Heiby, vice president and superintendent; Adolph Mueller, treasurer, and Fred L. Riggin, secretary, assistant treasurer and assistant general manager. The site comprises 73 acres and the buildings in course of erection include a foundry, 60 x 190 feet, and a brass finishing department, 60 x 256 feet. Richard Lau has been appointed foreman of the foundry and W. C. McIntyre has been appointed superintendent of the plating and polishing department.

## New Construction

The Kittoe Boiler & Tank Co., Canton, O., is building an addition to its foundry.

The American Malleable Co., Buffalo, will build a 100 x 150-foot addition to its foundry.

The Standard Foundry Co., Dayton, O., will build an addition to its plant on Bish avenue.

The Phoenix Iron Works Co., Meadville, Pa., will erect an addition to its foundry, 50 x 150 feet.

The Bass Foundry & Machine Co., Fort Wayne, Ind., will erect a 110 x 275-foot addition to its plant.

The McCracken Co., 925 Chamber of Commerce, Detroit, contemplates the erection of a foundry and machine shop.

The Hardwick Stove Co., Cleveland, Tenn., is building an addition to its foundry. Considerable equipment will be required.

W. H. Crockett, Princeton, W. Va., and J. W. McGuire, Gatto, W. Va., will erect a gray iron foundry at Bluefields, W. Va.

The United States Radiator Corporation is planning to erect an addition to its foundry at its Edwardsvills, Ill., plant.

The Wilkesbarre Iron Mfg. Co., Wilkesbarre, Pa., will erect a gray iron foundry, 142 x 111 feet.

The Griffin Wheel Co., Chelsea, Mass., will erect three new buildings, increasing its capacity to 500 car wheels per day.

The Center Foundry & Machine Co., Wheeling, W. Va., is doubling the capacity of its foundry and is constructing a new building for the cleaning department.

The Lewis Electric Welding & Mfg. Co., Toledo, O., will add a gray iron foundry to its plant, and a special department will be added for making gray iron piston rings.

The Western Crucible Steel Casting Co., Minneapolis, will erect a new plant which will have approximately 31,000 square feet of floor space. Provision will be made for the installation of open-hearth furnaces in the near future.

The Flynn & Emrich Co., founders and machinists, Baltimore, Md., are building a large addition to their foundry, and are rearranging the plant throughout. No equipment will be added. The product will include high grade machinery and architectural castings.

The Lynchburg Foundry Co., Lynchburg, Va., has awarded the contract for its 115 x 210-foot pipe plant, to be erected at Anniston, Ala. Machinery will be required including a blower, two cupolas, electric motors and a hydraulic pump. The daily output is expected to be about 100 tons of bell and spigot water and gas pipe.

The Carleton Place Foundry & Machine Co., Carleton Place, Ont., recently organized by T. Betts, W. H. Cousins and C. Firth, is erecting a foundry, 30 x 60 feet, for the manufacture of iron and brass castings. W. H. Cousins was formerly foreman of the machine shop of the Renfrew Machine Co. and Mr. Betts was formerly foreman of this company's foundry.

The National Cast Iron Pipe Co., Birmingham, has been incorporated with a capital stock of $200,000 to engage in the manufacture of cast iron pipe. A site has been purchased near Boyles, about five miles from Birmingham. The plant will be equipped to manufacture cast iron pipe in sizes from 4 to 30 inches. Officers have been elected as follows: A. H. Ford, president, E. E. Linthicum, vice president and general manager, and A. E. Nelson, secretary and treasurer.

The Baltimore Malleable Iron & Steel Co., Baltimore, is erecting several extensions to its foundry, including a shipping room and an annealing department. The casting and cleaning department also is being enlarged. A 20-ton air furnace is being installed, as well as a power plant with producer gas equipment to furnish electric power for the plant. The tumbling mills, fans, blowers, etc., will be direct motor-driven and the storage yard is being equipped with a trolley system for handling material.

## Among the Brass Founders

The American Rotary Valve Co., Anderson, Ind., is building a brass and iron foundry.

The Rome Brass & Copper Works, Rome, N. Y., will build a casting shop, 50 x 88 feet.

The Kokomo Brass Works, Kokomo, Ind., J. W. Johnson, treasurer and manager, is erecting an addition to its brass plant, 46 x 87 feet.

Thomas Savill & Sons, Philadelphia, will build a brass foundry at Watts and Wallace streets, for the manufacture of plumbers' brass goods.

William A. Hardy & Sons Co., brass founders, Fitchburg, Mass., are building a small addition to their foundry, consisting of a furnace and stock room.

The United Foundry & Machine Co., Bridgeport, Conn., has completed its new foundry on Connecticut and Bruce avenues. Aluminum, brass and bronze castings will be made.

The M. G. M. Mfg. Co., Detroit, recently incorporated, is erecting a machine shop and foundry at 1532 Fort street for the manufacture of special brass goods and air compressors. H. R. Haberkorn is president.

The L. C. Smith Co. 225 John street, Bridgeport, Conn., has started a brass foundry and will cast a special non-corrosive bronze into bars and billets for the manufacture of sheets.

The Chadwick Brass Co., Ltd., Hamilton, Ont., will add another foundry building. The present works include a large brass foundry for making brass, bronze and aluminum castings. Plans provide for the manufacture of aluminum cooking utensils and similar goods.

# Index to Volume XL

## January---December, 1912

### A


Accidents, Prevention of Foundry..... 220
Accidents in Steel Foundry, Prevention of 535
Acid Baths ..... 59
Acid Open-Hearth Casting Plant, Construction Features and Equipment..... 25
Acid Poisoning ..... 424
Air Compressor, Chicago Pneumatic Tool Co., Chicago ..... 438
Air Furnaces, Draftless Stoking Door for 337
Air Furnace Practice ..... 83
Air in Foundries, Compressed..... 519
Acid Stripping Solution ..... 320
Alloy, Anti-Corrosive .....418, 478
Alloy for Bushings ..... 18
Alloy, Cheap White Metal..... 528
Alloy for Casting in Iron Molds..... 418
Alloy Nomenclatures ..... 522
Alloys, Mixtures of Brass and Bronze, .....Data Sheet No. 120, August, 1912
Alloy of Copper, Nickel and Iron..... 319
Alloy Steel Casting Co., Wheeling, W. Va. 235
Alloy, Strong and Cheap..... 149
Alloys, Fusible, . .....Data Sheet No. 109, March, 1912
Alloys for Motor Car Service..... 525
Alloys for Soft White Metal Patterns..... 148
Alloys, Phosphorized . ..... 369
Alloy to Replace Brass..... 478
Alloys, Zinc and Aluminum..... 468
Aluminum Alloy and Die-Casting..... 59
Aluminum Alloys for Bells..... 478
Aluminum Alloy for Hollow Ware..... 417
Aluminum Bronze Bushings ..... 368
Aluminum Castings, Cadmium in..... 368
Aluminum Castings, Finished by Tumbling . ..... 139
Aluminum Castings, Finishing of ..... 204
Aluminum Castings, Sand for..... 478
Aluminum Founding in Mexico..... 304
Aluminum in Iron Molds, Casting of..... 194
Aluminum, Lead and Silicon in Brass.... 230
Aluminum Match-Plates, Manufacture of.. 221
Aluminum Propeller Blades ..... 193
Aluminum, Solder for ..... 380
Aluminum Solders ..... 37
Aluminum Ware, Cleaning of ..... 424
Aluminum Work, Green Sand Cores in... 141
American Foundry Industry, Statistics of. 329
American Institute of Metals.....152, 226
American Institute of Metals, Buffalo Meeting . ..... 473
An Effective Skim Gate..... 537
Anderson Oil Co. ..... 124
Annealing Boxes, Castings for..... 469
Annealing Brass Castings..... 111
Annealing Coinage Alloys..... 457
Annealing Oven, New Malleable,..... 212
Annealing Steel Castings, Furnace for... 79
Annual Meeting of the Chicago Foundrymen's Club ..... 208
Annual Meeting of Exhibition Co..... 539
Annual Meeting of Institute of Metals... 359
Anodes, Casting of Brass..... 205
Anodes, Nickel, Covered with Slime..... 205
Anti-Corrosive Alloy ..... 418
Anti-Corrosive Alloy ..... 478
Applications of Titanium, Recent..... 232
Apprentices, Training of Foundry..... 247
Arcade Mfg. Co., Freeport, Ill., Pattern Plates . ..... 259
Arcade Mfg. Co., Freeport, Ill., Stripping Plate Device ..... 382
Architectural Bronze Castings, Molding.. 227
Areas and Dimensions of a 25-Ton Open-Hearth Furnace ..... 464
Area of Irregular Figures, Methods of Finding the ..... .....Data Sheet No. 111, April, 1912
Argilite . ..... 407
Arsenic ..... 406
Artificial Patina ..... 360
Artistic Bronze Castings, Production of... 41
Associated Foundry Foremen, History of 530
Atomic Weights ..... 24
Australian Representative of The Foundry 208
Automobile Parts, Brass Plating for..... 138
Available Pig Iron Supply, Foundry and. 532


### B


Babbitt Metals ..... 478
Babbitt Mixtures ..... 18
Babbitts, Mixtures for ..... 110
Bearing Alloy ..... 306
Bearing Bronze, Smith's ..... 149
Bed Plate, Sweep-Molding a Circular..... 163
Bell Metal Mixtures ..... 528
Bells, Aluminum Alloy for..... 478
Bibbs and Globe Valves, Mixture for..... 282
Black Dip for Brass..... 322
Black Nickel Formula ..... 94
Blast Furnace Tuyeres..... 73
Blast Furnace Tuyeres, Mixture for..... 18
Blast Meter for Cupola, Clark..... 436
Blow-Holes in Brass Castings..... 478
Blow-Holes, Some Causes of..... 390
Blower Unit, Turbine-Driven..... 78
Blue-Black Finish ..... 60
Ph. Bonvillain & E. Ronceray, Paris, Molding Machine Installations..... 335
Borings, Melting of ..... 68
Brackets for Street Railway, Machine-Molded . ..... 77
Brass Anodes, Casting of..... 205
Brass, Black Dip for..... 322
Brass Castings, Annealing of..... 111
Brass Castings, Blow-Holes in..... 478
Brass Castings, Discoloration of..... 194
Brass Castings for Hydraulic Pressure.... 232
Brass Castings, Porosity in..... 310
Brass Deposit, Heavy ..... 94
Brass, Dipping ..... 111
Brass, Electro-Deposition of..... 203
Brass Finish, Flemish ..... 234
Brass Founders' Association ..... 124
Brass Foundry Burns ..... 309
Brass Foundryman, Formulas for, Data Sheet No. 120, August, 1912.
Brass Foundryman, Formulas for, Data Sheet No. 115, June, 1912.
Brass Foundryman, Formulas for, Data Sheet No. 109, March, 1912.
Brass Foundryman, Useful Information for, Data Sheet No. 106, January, 1912.
Brass Foundry Practice, English..... 281
Brass, Fuel Melting Ratio for..... 418
Brass Furnace for Melting Steel..... 200
Brass Into Steel, Casting of..... 369
Brass, Lead, Silicon and Aluminum in.... 230
Brass Melting, High Pressure Gas for... 280
Brass Molders' Tubs ..... 149
Brass Pipe Fittings, Leaks in..... 230
Brass Plating for Automobile Parts..... 138
Brass, Sand Mixtures for Cores for..... 111
Brass Scrap, Red ..... 73
Brass Solution, How to Operate..... 276
Brass, Yellow ..... 528
Brazing Solders, Data Sheet No. 115, June, 1912.
Briquettes, Use of Iron and Steel..... 106
British Foundrymen's Conference at Cardiff . ..... 370
British Methods for Testing Molding Sands 401
Bronze Castings, Molding Architectural... 227
Bronze Castings, Ornamental, Molding of 187
Bronze Fractures, Gray and Yellow Spots in . ..... 310
Bronze Gears, Mixture for..... 282
Bronze, Hard Phosphor ..... 282
Bronze Injectors, Molding of..... 101
Bronze Plate, Defective Circular..... 529
Bronze, Plumbic ..... 310
Bronzes, Wearing Qualities of..... 463
Bronzes, Wear of..... 418
Buffalo Exhibition of Foundry Equipment 453
Buffalo Heartily Welcomes Allied Foundrymen . ..... 385
Buffalo Meeting of American Foundrymen 441
Buffalo Metal Fest From Two Angles... 531
Buffalo Prepares for Foundrymen's Invasion . ..... 377
Building an Intricate Burring Machine Pattern . ..... 198
Burner for Furnace, Hauck ..... 255
Burring Machine Pattern, Building of.... 198
Bushings, Alloy for..... 18
Bushings, Aluminum Bronze ..... 358


BOOK REVIEWS


Annual Statistical Report of the American Iron & Steel Association for 1911, Part II . ..... 540
Casting of Iron and Non-Ferrous Metals 166
Engineering as a Vocation..... 166
Foundry Practice ..... 166
Hawkins Mechanical Dictionary..... 82
Hendricks' Commercial Register..... 432
Iron and Steel Foundry Practice..... 166
Maximum Production ..... 82
Metallography of Iron and Steel..... 496
Metallurgy . ..... 82
Physical Test and Chemical Analyses of Iron and Steel ..... 166
Second Supplement to the Directory of the Iron and Steel Works of the United States . ..... 166
Technical Analysis of Brass and the Non-Ferrous Alloys ..... 82


### C


Cadmium in Aluminum Castings..... 368
Canadium . ..... 70
Carbonate of Copper ..... 425
Car Wheels, Cast Iron, Chills in..... 153
Cast Aluminum, Filling Shrink-Holes in.. 404
Cast Iron ..... 541
Cast Iron Car Wheels, Controlling Mixtures for ..... 153
Cast Iron, Constitution of..... 326
Cast Iron, Expansion of..... 83
Cast Iron for Copper-Plating..... 60
Cast Iron, Origin of Shot in..... 516
Cast Steel Gears, Machine Molding of... 458
Casting a 120-Ton Iron Engine Bed Plate 305
Casting Aluminum in Iron Molds..... 194
Casting Brass Anodes ..... 205
Casting Brass Into Steel..... 369
Casting Brass on Steel..... 417
Casting Copper in a Permanent Mold... 415
Casting Manganese Bronze, Suggestions for . ..... 282
Casting Pure Copper in Sand Molds..... 229
Casting Silver ..... 417
Casting Works of Art in Bronze..... 18
Casting Wrought Iron in Cast Iron..... 176
Casting German Silver, Difficult Art of.. 486
Casting Steel in Electric Induction Furnaces . ..... 357
Castings, Influence of Heat on..... 8
Castings, Estimating Price of..... 156
Castings, Finishing Aluminum..... 204
Castings, Making Basic Open-Hearth Steel for . ..... 523
Castings of Rich Color..... 310
Castings, Thin Chinese ..... 197
Center of Gravity of Irregular Figures, Method of Finding the, Data Sheet No. 112, April, 1912.
Chain Belt Co.'s Gray Iron Foundry, Milwaukee . ..... 419
Chandelier Castings, Mixture for..... 148
Chart of Elements ..... 346
Cheap White Metal Alloy..... 528
Chemical Laboratory of a Large Steel Foundry . ..... 195
Chemical Work, Gray Iron Castings for 394
Chicago Fire Brick Co..... 156
Chicago Foundrymen's Club.....117, 272
Chicago Foundrymen's Club, Annual Meeting of ..... 208
Chicago Steel Foundry Co.'s Steel Casting Shop . ..... 395
Chillable Iron Tests ..... 264
Chilled Wheels, Cracks in..... 117
Chilled Wheels, Rough Treads on..... 488
Chinese Castings, Thin ..... 197
Chipping Steel Castings with a Pneumatic Hammer ..... 291
Circular Bronze Plate, Defective..... 529
Clark Cupola Blast Meter ..... 436
Clean Stove Plate ..... 356
Cleaning Aluminum Ware ..... 424
Cleaning Enamel ..... 140
Cleaning, Iron ..... 94
Cleaning Nickel Solutions.....276, 361
Cleaning Solution, Electric..... 518
Cleveland-Wardsworth Sand Blast Machine ..... 380
Coinage Alloys, Annealing of..... 457
Coloring Copper Objects ..... 205
Colors, Producing, by Electro-Deposition.. 524
Combination Jar-Ramming and Turn-Over Draw Molding Machine..... 491
Combination of Crucible and Converter Steel Casting Processes..... 395
Combination Molding Machine.....38, 167
Combination Sand Mixer ..... 39
Combined Jar-Ramming, Pattern Drawing and Squeezer Molding Machine..... 293
Commercial Tendencies in Malleable Practice . ..... 431
Commonwealth Steel Co. Chemical Laboratory . ..... 195
Comparative Heat Value of Fuels, Data Sheet No. 119, August, 1912.
Comparison of Green and Dry Sand Cores 208
Compressed Air in Foundries..... 519
Concrete Foundry Floors ..... 301
Constituents of Foundry Coke, Methods for Determining the, Data Sheets Nos. 125 and 126, November, and No. 127, December, 1912.
Constitution of Cast Iron ..... 326
Construction Features of a Model Stove Foundry . ..... 323

Construction of a Modern Foundry..... 283
Conventions of Foundrymen's Associations and Foundry Exhibit, Buffalo..... 385
Converter Practice, European ..... 101
Copper Alloys, Effect of High Temperatures on ..... 108
Copper Alloys for Motor Car Service.... 525
Copper Alloys, Silicon in..... 110
Copper and Brass Finishes ..... 139
Copper and Its Alloys, Deoxidation of... 460
Copper and Its Alloys, Early History of.. 95
Copper and Its Alloys, Oxy-Acetylene Welding of ..... 457
Copper and Nickel, Shotting of..... 529
Copper, Casting, in Sand Molds..... 229
Copper Castings Free from Blow-Holes.. 436
Copper Castings, Shrinkage of..... 231
Copper-Plating, Cast Iron for..... 60
Core and Annealing Ovens..... 439
Core and Mold Sprayer ..... 80
Core Binders ..... 37
Core Box Plane ..... 294
Core Box Plane of Gray Iron Castings Co., Springfield, O..... 294
Core Machine, Hewlett ..... 120
Core Oven Cars, Machine for Handling.. 211
Core Oven Installations.....181, 382
Core Wire Straightening Machine..... 37
Corrosion of Manganese Propellers..... 122
Cost of Fuel for Melting Aluminum..... 417
Cost of Making Steel in Electric Induction Furnaces ..... 357
Cost of Production, Patterns and the..... 116
Cost System for Foundries.....127, 507
Cover for Crucibles, Modern Equipment Co., Providence, R. I..... 439
Covering Risers on Molds..... 133
Cracks in Chilled Wheels..... 117
Crane Chains, Strength of, Data Sheet No. 116, June, 1912.
Crane, Light Capacity..... 168
Crank Pin Bearings ..... 148
Crucible and Converter Steel Casting Shop 395
Crucible Cover ..... 439
Crucible Furnace, German..... 146
Crucible Furnaces, Lifting-Out Hook for. 433
Crucible Lifting Device..... 146
Crucible Steel Castings ..... 243
Cupola Blast, Water in..... 539
Cupola Bridging ..... 391
Cupola Lining, Repairing of..... 319
Cupola Management and Operation..... 302
Cupola, Operation of..... 262
Cupola Slag, Excessive..... 201
Cupola Spout, Tilting ..... 181
Cutler-Hammer Clutch Co., New 24-Inch Lifting Magnet ..... 541
Cutler-Hammer Magnetic Separator..... 210
Cyanide Copper Solution, Hot..... 90
Cylinders, Molding, on an Electric Jar-Rammer ..... 185
Copper Deposits, Flaking of..... 204
Copper, Nickel and Iron, Alloy of..... 319
Copper Objects, Coloring of..... 205
Copper, Phosphorus Hardened..... 231


## D


Dead Nickel Surfaces ..... 233
Death of James Miller Jack..... 539
Decorative Green Finishes ..... 360
Dedication of Martin Fox Memorial..... 312
Defective Circular Bronze Plate..... 529
Deoxidation of Copper and Its Alloys.... 460
Design and Manipulation of an Open-Hearth Furnace ..... 464
Design for Gated Metal Patterns..... 307
Detachable Open-Hearth Furnaces, Alloy Steel Casting Co., Glenova, Wheeling, W. Va. ..... 235
Detection of Arsenic ..... 362
Devices for Molding Economies..... 215
Device for Pattern-Drawing..... 433
Difficult Art of Casting German Silver... 486
Difficult Crucible Steel Casting..... 243
Difficulties in Making Sound Castings... 524
Difficulties of Green Sand Molding..... 415
Difficulties, Shrinkage ..... 528
Difficulties, Steel Rolls ..... 510
Difficulties with Nickel Solution..... 93
Difficulties with Spongy Iron..... 132
Difficulty in Casting German Silver..... 310
Dipping Brass ..... 111
Dipping for Gold Tint..... 59
Direct-Draw, Roll-Over Jolt-Ramming Machine, Osborn Mfg. Co., Cleveland.... 379
Discoloration of Brass Castings..... 194
Discussion of British Brass Foundry Practice ..... 71
Discussion of Modern Brassfounding..... 363
Discussion of Mr. West's Papers..... 269
Draftless Stoking Door for Air Furnaces. 337
Dull Iron ..... 80
Dull Iron and Cupola Bridging..... 391
Duplex Copper Baths, Operation of..... 137


## E


Early History of Copper and Its Alloys. 95
Economical Foundry Handling Equipment 438
Economical Operation of Molding Machines 392
Economies and Developments in Pattern-making ..... 352
Economies in Melting Brass in an Electric Furnace ..... 483
Economies in Molding Practice..... 215
Effect of High Temperatures on Copper Alloys ..... 108
Effect of Impure Metals on Manganese Bronze ..... 417
Efficiency Movement in the Foundry..... 47
Eight-Hour Shift in the Steel Foundry.. 461
Electric Cleaning Solution..... 518
Electric Furnace for Non-Ferrous Metals 69
Electric Furnace, Melting Bronze in the.. 368
Electric Furnace Reactions..... 428
Electric Induction Furnace for Cast Steel. 357
Electric Jar-Rammer, Use in Molding Cylinders ..... 185
Electro-Deposition of Brass..... 203
Electro-Deposition, Producing Colors by.. 524
Electro-Galvanizing Solution ..... 362
Elements, Chart of ..... 346
Emergency Jobs in Bucyrus Co.'s Foundry, South Milwaukee, Wis. ..... 135
Engine Bed Plates, Casting of..... 305
English Brass Foundry Practice..... 281
English Gas Engine Cylinder Foundry... 426
English, German and American Methods of Making German Silver..... 486
Enlarging Iron and Steel Objects by Plating ..... 276
Equipment and Management of Nickel Baths—I ..... 515
Equipment for the Foundry and Pattern Shop ..... 209
Equipment of a Modern Brass Foundry.. 9
Esculator, Chain Belt Co., Milwaukee... 438
Essential Features of a Cost System for Foundry Work ..... 127
Estimating Price of Castings..... 156
European Converter Practice..... 101
Excessive Shrinkage of White Metal..... 282
Excessive Slag ..... 306
Excessive Slag in the Cupola..... 201
Exhibit of Foundry Equipment at Buffalo 453
Exhibit of Non-Ferrous Alloys..... 333
Exhibition Co., Annual Meeting of..... 539
Exhibitors at Buffalo Convention..... 453
Expansion of Cast Iron ..... 83
Experimental Tests of White Metals for Engines ..... 482
Experiments with Car Wheel and Alloyed Irons ..... 264
Explosive Antimony ..... 46
Eye Protection for Foundry Employes.... 335


EDITORIALS


Accident Prevention in Foundries..... 292
Bouquet for the Editor..... 118
Blazing the Trail..... 207
Demand for Skilled Molders..... 164
Electric Furnace for Foundry Work..... 538
Estimating Prices for Castings..... 164
Foundry Industry in 1912..... 334
Foundry Trade in Retrospect..... 36
Founders' Week at Buffalo..... 434
Horrors of the Drop Bottom..... 64
Originality Rewarded ..... 252
Pig Iron Brands Essential?..... 119
Publicity for Molding Time Data..... 75
Quality of Pig Iron..... 206
Record Pig Iron Production..... 378
Semi-Steel, A Misnomer?..... 75
Shot in Gray Iron..... 252
Steel Casting Output in 1911..... 207
Test Bar Joke..... 74
The Foundry Convention ..... 490
The Passing Throng..... 165
Trade Outlook .....74, 118, 165, 206, 252, 292, 334, 378, 434, 538


## F


Filling Pin Holes in Gas Engine Cylinders 425
Filling Shrink-Holes in Cast Alum'm193, 404
Finishes for Nickel, Copper and Brass... 233
Finish, Gun Metal..... 362
Finish, Japanese Bronze ..... 362
Finish, Military Bronze..... 204
Finish, Rose Gold ..... 276
Finish, Snow Flake ..... 517
Finishing Aluminum Castings..... 204
Finishing Aluminum Castings by Tumbling ..... 139
Finishing Steel Hooks ..... 321
Fire Brick Tapping Hole..... 17
Fire Protection in Foundries..... 294
First Aid to the Injured..... 346
Flaking of Copper Deposits..... 204
Flask, Tuohy Interchangeable..... 540
Fleming Brass Finish ..... 234
Floor Rammer, Pneumatic, Cleveland Pneumatic Tool Co., Cleveland, O..... 296
Floor Space, Utilization of..... 359
Flux for Yellow Brass..... 149
Foreign Molding Machine Installations... 134
Formulas for Finding the Weights of Iron Castings, Data Sheets Nos. 107 and 108, February, 1912.
Formulas for Finding the Weights of Iron Castings, Data Sheets Nos. 113 and 114, May, 1912.
Formulas for Finding the Weights of Iron Castings, Data Sheets Nos. 117 and 118, July, 1912.
Formula for Silvering ..... 234
Formula for Steam Metal ..... 18
Formulas for the Brass Foundryman, Data Sheet No. 109, March, 1912.
Formulas for the Brass Foundryman, Data Sheet No. 115, June, 1912.
Formulas for the Brass Foundryman, Data Sheet No. 120, August, 1912.
Formulas for the Foundryman, Useful, Data Sheet No. 110, March, 1912.
Founding, Loss of Skill in..... 356
Foundry Accidents, Prevention of..... 220
Foundry Accidents, Suggestions for Prevention of ..... 178
Foundry and Available Pig Iron Supply 532
Foundry and Pattern Shop, Equipment for 209
Foundry Apprentices, Suggestions for Training ..... 347
Foundry Apprentices, Training of..... 347
Foundry, Australian Representative of.... 208
Foundry Coke, Determining the Constituents of, Data Sheets Nos. 125 and 126, November, 1912.
Foundry Cost System ..... 127
Foundry Cost System that Produced Results ..... 507
Foundry Course in Newark Technical School ..... 56
Foundry Cupola, Scientific Management of 408
Foundry Employes, Eye Protection for... 335
Foundry Equipment Installations, J. D. Smith Foundry Supply Co., Cleveland, Ohio ..... 291
Foundry Floor, Kettle River Co., Minneapolis ..... 251
Foundry Floor, New Type ..... 251
Foundry Floors, Concrete ..... 331
Foundry Fuel, Liquid ..... 489
Foundry Ladles ..... 152
Foundry Ladle, Jacketed ..... 150
Foundry Nails ..... 404
Foundry Practice in Great Britain..... 71
Foundry Refuse, Recovering Metal from.. 495
Foundry Refuse, Recovering of Iron from. 161
Foundry Roof ..... 46
Foundry, Scientific Operation of a..... 6
Foundry Specializing in Machinery Castings ..... 479
Foundry Trade, Thirty Years in..... 208
Foundryman, Useful Information for, Data Sheet No. 116, June, 1912.
Foundryman, Useful Information for, Data Sheet No. 119, August, 1912.
Foundrymen's Association, New England. 77
Foundrymen's Convention in Buffalo in September ..... 124
Foundrymen's Convention at Buffalo..... 170
Fox, Martin, Memorial. Unveiling of.219, 312
Franklin Core Rod & Gagger Co. Twisted Steel Gaggers ..... 492
Free-Cutting Red Brass..... 148
French Emergency Cupola ..... 46
French Gold ..... 94
French Gray Finish..... 205
French Molding Machine Installation..... 335
French Molding Machines, Orders for... 494
Friction Drum Castings, Molding of, on Machines ..... 297
Fuels, Comparative Heat Value of, Data Sheet No. 119, August, 1912.
Fuel Melting Ratio for Brass..... 418
Fuel-Oil Burners for Open-Hearth Furnaces ..... 112
Fuel Ratios for Cupola Melting..... 66
Fuels, Weights of, Data Sheet No. 119, August, 1912.
Furnace Burner, Hauck ..... 255
Furnace for Annealing Steel Castings.... 79
Furnace for Melting Non-Ferrous Metals, Pittsburgh Electric Furnace Co., Pittsburgh ..... 69
Furnaces Used for Melting Copper and Brass in Great Britain ..... 71
Fusible Alloys, Data Sheet No. 109, March, 1912.


## G


Gaggers, Twisted Steel ..... 492
Galvanizing Small Sheet Steel Products.. 134

Gas Engine Cylinders, Filling Pin Holes in . . . . . 425
Gas Lamps, Use of . . . . . 514
Gate, Simple Strainer . . . . . 534
Gated Metal Patterns, Design for . . . . . 307
German Crucible Furnace . . . . . 146
German Silver, Difficulty in Casting . . . . . 310
German Silver for Valves . . . . . 310
Germany's Bronze Powder Industry . . . . . 58
Globe Valve Bodies, Shrinkage in . . . . . 56
Gold Bronze . . . . . 94
Gold Bronze Solution . . . . . 205
Gold Color on Sheet Brass . . . . . 234
Gold Finish, Ormulu . . . . . 94
Gold Tint, Dipping for . . . . . 59
Grab Bucket, Foundry, Pawling & Harnischfeger Co. . . . . 255
Graphite Exports, Korean . . . . . 351
Graphite in India, Mining and Sorting . . . 315
Gray and Yellow Spots in Bronze Fractures . . . . . 313
Gray Finish, French . . . . . 205
Gray Iron Castings for Chemical Work . . 394
Gray Iron Castings, New Processes for Chilling . . . . . 244
Gray Iron Castings, Tinning of . . . . . 140
Gray Iron Sections for Turbines, Methods of Molding . . . . . 182
Gray Iron Shop of Fulton Iron Works, St. Louis . . . . . 479
Gray Iron Turbine Casting, Molding a 26-Ton . . . . . 277
Green Copper Finishes . . . . . 233
Green and Dry Sand Cores Compared . . . . . 208
Green Finish by Electro-Plating . . . . . 361
Green Sand Cores in Aluminum Work . . . 141
Greenish Brown Color on Brass . . . . . 138
Grinding Wheels, Protection Hoods for . . . 381
Gun Metal Finish . . . . . 362


## H


Hard Enamel, Removing of . . . . . 94
Hard Phosphor Bronze . . . . . 282
Hard Scrap for Soft Castings . . . . . 421
Hauck Furnace Burner . . . . . 255
Heating Crucibles with Gas, New Method of . . . . . 50
Heat, Influence of, on Castings . . . . . 8
Heavy Brass Deposit . . . . . 94
Herman Pneumatic Machine Co., Jar-Ramming Molding Machine . . . . . 493
Herman Pneumatic Machine Co., Zelienople, Pa., Jar-Ramming Machine . . . . . 293
Hewlett Core Machine . . . . . 120
High Pressure Gas for Brass Melting . . . . 280
High Sulphur . . . . . 337
High Temperatures, Effect of, on Copper Alloys . . . . . 108
Hill & Griffith Co., Cincinnati, O., New Core Machine . . . . . 169
Hinged Match-Plate Work, Improvements in . . . . . 85
History of the Associated Foundry Foremen . . . . . 530
Hollow Ware, Aluminum Alloy for . . . . . 417
Hot Cyanide Copper Solution . . . . . 90
House Heating Boiler Castings, Leaky . . . 391
How to Cast Lead . . . . . 529
How to Clean Aluminum Ware . . . . . 424
How to Detect Arsenic . . . . . 362
How to Melt Iron to Obtain the Best Results . . . . . 503
How to Mold a Small But Intricate Casting. . . . . 405
How to Operate a Brass Solution . . . . . 276
How to Paint Patterns . . . . . 336
How to Prevent the Pitting of Nickel Deposits . . . . . 322
Hubbard Steel Foundry Co . . . . . 211
Hydraulic Pressure, Brass Castings for . . 232


## I


Ice-Cooled, Sanitary Drinking Fountain . . . 336
Improper Sand, Use of . . . . . 418
Improved Foundry Grab Bucket . . . . . 225
Improvements in Hinged Match-Plate Work. . . . . 85
Increase of Density in Pressure Casting . . 311
Information for the Brass Foundryman, Data Sheet No. 106, January, 1912.
Information for the Foundryman, Data Sheet No. 105, January, 1912.
Ingot Copper Versus Scrap Wire . . . . . 529
Injectors, Bronze, Molding of . . . . . 101
Injured, First Aid to . . . . . 346
Ink Prints, Transfer of . . . . . 93
Institute of Metals . . . . . 37
Institute of Metals, Annual Meeting of . . . 359
Interchangeable Flask, Tuohy . . . . . 540
International Congress for Testing Materials. . . . . 335
International Exhibition of Non-Ferrous Alloys, London. . . . . 333
International Molding Machine Co., Combination Molding Machine . . . . . 491
Investigation of Metal Losses . . . . . 416
Investigation of the Iron Melting Problem 456
Iron and Brass Foundry in Switzerland . . 133
Iron and Steel Briquettes, Use of . . . . . 136
Iron and Steel Objects, Enlargement of, by Plating. . . . . 276
Iron Castings, Formulas for Finding the Weights of, Data Sheets Nos. 107 and 108, February, 1912.
Iron Melting Problem, Investigation of . . 456
Iron, Mixing and Melting, by Analysis . . 157
Iron Mixture, Mock . . . . . 60
Iron Mixtures, Weighing of . . . . . 83
Iron Molds, Alloy for Casting in . . . . . 418
Iron Molds for Casting Aluminum . . . . . 194
Iron, Mottled Malleable . . . . . 263
Iron, Segregation and Shot in . . . . . 159
Iron Smoke Stacks, Molding of . . . . . 202
Iron Tests, Chillable . . . . . 264
Irregular Figures, Methods of Finding the Area of, Data Sheet No. 111, April, 1912.
Irregular Figures, Method of Finding the Center of Gravity of, Data Sheet No. 112, April, 1912.


## J


Jacketed Foundry Ladle . . . . . 150
Jackman & Co., J. W., Ltd., London, Show Room. . . . . 414
James Miller Jack, Death of . . . . . 539
Japanese Bronze Finish . . . . . 362
Jar-Ramming Machine, Plain . . . . . 125
Jar-Ramming Machine with Pattern-Drawing Cylinders. . . . . 209
Jar-Ramming, Roll-Over and Pattern Drawing Machine, Shockless . . . . . 253
Jar-Ramming, Roll-Over Molding Machine. 256
Jarring Machine, 120,000-pound . . . . . 78
Joining Metals. . . . . 452
Jolt-Ramming Machine, New Valve for . . . 79


## K


Killing Molding Machines . . . . . 348
Knives, Refinishing Steel . . . . . 517
Korean Graphite Exports . . . . . 351


## L


Labor-Saving Devices in a Brass Foundry. 9
Labor-Saving Equipment in a Radiator Foundry. . . . . 1
Labor-Saving Molding Devices in Hinged Match-Plate Work, McClary Mfg. Co., London, Ont. . . . . 85
Ladle for Foundry, Jacketed . . . . . 150
Latest Development of the Permanent Mold. . . . . 173
Lead, How to Cast . . . . . 529
Lead, Segregation of . . . . . 529
Lead, Silicon and Aluminum in Brass . . . . 230
Leaks in Brass Pipe Fittings . . . . . 230
Leaky House Heating Boiler Castings . . . . 391
Lidgerwood Mfg. Co.'s Gray Iron Foundry, Newark, N. J. . . . . 297
Lifting Magnet, New 24-Inch . . . . . 541
Lifting-Out Hook for Crucible Furnaces . . 433
Light Capacity Crane . . . . . 168
Lining for a Nickel-Plating Tank . . . . . 425
Liquid Core Binders . . . . . 493
Liquid Fuel in the Foundry . . . . . 489
Loss of Skill in Founding . . . . . 356
Lumen Bearing Co.'s Brass Foundry . . . . . 9


## M


McClary Mfg. Co., London, Ont., Aluminum Match-Plates. . . . . 221
Machine for Handling Core Oven Cars . . . 211
Machine for Straightening Core Wire . . . . . 37
Machine Molded Gears, Making Patterns for . . . . . 511
Machine-Molded Street Railway Brackets. 77
Machine Molding of Large Cast Steel Gears. . . . . 458
Machinable Manganese Steel Castings . . . . 271
Machinery Castings, Special Foundry for. 479
Magnetic Separator, Cutler-Hammer . . . . . 210
Making a Pattern for a Parsons' Steam Turbine . . . . . 499
Making Aluminum Match-Plates, Goodale Co., Kalamazoo, Mich. . . . . 221
Making and Assembling Cores for a Water-Cooled Gas Engine Cylinder . . . . 426
Making and Casting Nickelene or Silver Metal . . . . . 351
Making Basic Open-Hearth Steel for Castings . . . . . 523
Making Manganese Steel Castings Machinable. . . . . 271
Making Patterns for Machine Molded Gears—I . . . . . 511
Making Sound Castings, Difficulties in . . . . 524
Making Steel Castings by the Crucible Process . . . . . 339
Making Steel Castings for the Panama Canal. . . . . 349
Malleable Iron, Mottled . . . . . 132, 263
Malleable Iron Stove Plate, Methods Used at Malleable Iron Range Co., Beaver Dam, Wis. . . . . 61
Malleable Iron Stove Plate, Manufacture of 61
Malleable Practice, Commercial Tendencies in. . . . . 431
Management and Operation of Cupolas . . . . 302
Manganese as a Purifying Agent . . . . . 68
Manganese Bronze. . . . . 56
Manganese Bronze, Effect of Impure Metals on. . . . . 417
Manganese Bronze, Molding and Casting of 147
Manganese Bronze, Pouring Temperature of. . . . . 487
Manganese Bronze, Suggestions for Casting 282
Manganese Steel Castings, Making, Machinable. . . . . 271
Manila Rope, Strength of, Data Sheet No. 116, June, 1912.
Manufacture of Aluminum Match-Plates . . 221
Manufacture of Malleable Iron Stove Plate. . . . . 61
Manufacture of Steel Flasks . . . . . 437
Manufacturing Equipment & Engineering Co., Boston, Sanitary Drinking Fountain 336
Marine Brass Work, Mixtures for . . . . . 369
Matte-Finishing. . . . . 60
Measurements, Temperature, Data Sheet No. 110, March, 1912.
Mechanical Electroplating Machine, Frederic B. Stevens Co . . . . . 169
Medical Hints for the Plater . . . . . 422
Meeting of American Institute of Metals. 473
Melting Aluminum, Cost of Fuel for . . . . . 417
Melting and Molding Devices Used by the Ancients. . . . . 95
Melting Borings. . . . . 69
Melting Brass, High Pressure Gas for . . 280
Melting Brass in an Electric Furnace . . . . 483
Melting Bronze in the Electric Furnace . . 368
Melting Iron in a Ladle . . . . . 177
Melting Iron to Obtain the Best Results. 503
Melting Steel in a Brass Furnace . . . . . 200
Memorial, Dedication of Martin Fox . . . . . 312
Memorial, Unveiling, of Martin Fox . . . . . 219
Merwin Mfg. Co., Erie, Pa., Foundry Nails. . . . . 404
Mesta Machine Co.'s Foundry, Pittsburgh. 305
Mesta Machine Co.'s Products . . . . . 380
Metal Fest at Buffalo From Two Angles. 531
Metal Losses, Investigation of . . . . . 416
Metal, Tests of Monel . . . . . 505
Methods for Testing Molding Sands . . . . . 401
Methods of Finding the Area of Irregular Figures, Data Sheet No. 111, April, 1912.
Methods of Finding the Center of Gravity of Irregular Figures, Data Sheet No. 112, April, 1912.
Methods of Molding and Alloys Employed in Making Artistic Bronze Castings . . . . 41
Microscope, Use of, in Making Cast Iron Car Wheels. . . . . 153
Microscopical Examination in Testing Molding Sands. . . . . 401
Military Bronze Finish . . . . . 204
Mining and Sorting Graphite in Far-Off India. . . . . 315
Mixing and Melting Iron Scientifically . . . . 157
Mixture for Bibbs and Globe Valves . . . . . 282
Mixture for Blast Furnace Tuyeres . . . . . 18
Mixture for Bronze Gears . . . . . 282
Mixture for Chandelier Castings . . . . . 148
Mixture for White Metal Pattern . . . . . 418
Mixtures, Bell Metal . . . . . 528
Mixtures for Babbitts . . . . . 110
Mixtures for Marine Brass Work . . . . . 369
Mixtures for Plumbers' Goods . . . . . 18
Mixtures for Brass and Bronze Alloys Used in English Practice, Data Sheet No. 120, August, 1912.
Mixtures of Iron, Selection of . . . . . 314
Mock Iron Mixture . . . . . 60
Model Sand Blasting Room . . . . . 201
Modern Acid Open-Hearth Steel Casting Plant. . . . . 25
Modern Brass Founding, Discussion of . . . 363
Molding and Casting Large Castings at Small Cost. . . . . 135
Molding and Casting Manganese Bronze . . 147
Molding and Melting Practice of the Sivyer Steel Casting Co . . . . . 339
Molding Architectural Bronze Castings . . . 227
Molding a 26-ton Casting at the Builders Iron Foundry, Providence, R. I . . . . . 277
Molding a Water-Cooled Gas Engine Cylinder. . . . . 426
Molding Cylinders on an Electric Jar-Rammer. . . . . 185
Molding Friction Drum Castings on Machines. . . . . 297
Molding Gas Engine Pistons . . . . . 162

Molding Intricate Castings..... 405
Molding Intricate Castings at a Milwaukee Foundry. ..... 419
Molding Iron Smoke Stacks..... 202
Molding Large Castings in an English Foundry. ..... 182
Molding Large Cast Steel Gears by Machine. ..... 458
Molding Machines, Economical Operation of. ..... 392
Molding Machine Installation, French.... 335
Molding Machine, Power Turn-Over and Power Draft. ..... 121
Molding Machine Work, Pattern Plates for. 259
Molding of Intricate Castings at Hudson Foundry Co., Jersey City, N. J..... 405
Molding Ornamental Bronze Castings.... 187
Molding Practice for Large Steel Castings 469
Molding Sands, British Methods of Testing. ..... 401
Molding Sand Shipments..... 258
Molding Steel Castings at the Hubbard Steel Foundry Co., East Chicago, Ind.. 469
Molding Time Data, Publicity for..... 75
Molds and Cores, New Facing for..... 208
Monel Metal, Tests of..... 505
Motor Cars, Copper Alloys for..... 525
Mottled Malleable Iron..... 132
Mottled Malleable Iron..... 263
Mounting Patterns on Molding Machines.. 392


## N


New Alloy of High Tensile Strength..... 107
New Aluminum Solder..... 439
New Core Box Plane..... 294
New Core Machine..... 169
New Electric Furnace for Melting Brass.. 483
New Electroplating Processes..... 60
New England Foundrymen's Association.. 77
New England Foundrymen's Association.. 496
New Facing for Cores and Molds..... 208
New Hot Galvanizing Process..... 496
New Malleable Annealing Oven..... 212
New Method of Heating Crucibles with Gas. ..... 50
New Parting Compound..... 156
New Processes for Chilling Gray Iron Castings. ..... 244
New Shop of Favorite Stove & Range Co., Piqua, O. ..... 323
New Stripping Plate Device..... 382
New 24-Inch Lifting Magnet..... 541
New Type of Air Compressor..... 438
New Type of Foundry Floor..... 251
New Valve for Jolt-Ramming Machine.... 79
New Western Roll Foundry..... 211
Newark Technical School's Foundry Course 56
Nickel Anodes Covered with Slime..... 205
Nickel Baths, Equipment and Management of ..... 515
Nickel, Copper and Brass, Finishes for.... 233
Nickel Deposits, How to Prevent the Pitting of. ..... 322
Nickel Deposits, Pitting of..... 59
Nickelene, Melting and Casting..... 351
Nickel Solution, Difficulties with..... 93
Nickel Solutions, Cleaning, of.....276, 361
Nickel Stripping Solution..... 275
Nickel-Plated Surface, Spotted..... 275
Nickel-Plating, Pointers on..... 57
Nickel-Plating Solution, Trouble with.... 275
Nickel-Plating Steel Strips..... 322
Nickel-Plating Steel Tubes ..... 517
Nickel-Plating Tank, Lining for..... 425
Nile Green Finish..... 59
Nomenclatures, Alloy ..... 522
Non-Ferrous Alloys, Exhibition of..... 333
Non-Ferrous Metals, Electric Furnace for 69
Northern Engineering Works, Detroit, Mich., Light Capacity Crane..... 168
Notes on Foundry Practice..... 540
Notes on Specific Gravity, Data Sheets Nos. 123 and 124, October, 1912.
Novel Core Testing Machine..... 76
Novel Wire Scratch Brush, Simplex Brush Co., Cleveland, O..... 295


## O


Open-Hearth Furnace Design and Manipulation. ..... 464
Open-Hearth Furnace of a Detachable Type ..... 235
Open-Hearth Furnaces, Operation of..... 112
Operating a Cupola..... 262
Operating Open-Hearth Furnaces with Eight-Hour Shifts. ..... 461
Operation of Cupola, Suggestions for..... 66
Operation of Duplex Copper Baths..... 137
Operation of Small Open-Hearth Furnaces. 112
Orders for French Molding Machines..... 494
Origin of Shot in Cast Iron..... 516
Ormulu Gold Finish..... 94
Ornamental Bronze Castings, Molding of.. 187
Osborn Vibrator ..... 336
Outside and Inside Chills in Iron Castings. 244
Oxidized Silver Finish..... 424
Oxy-Acetylene Welding of Copper and Its Alloys. ..... 457


OBITUARIES


Bullock, George Saunders..... 380
Corbin, William Horace..... 496
Farrell, Franklin ..... 81
Gow, John ..... 36
Jack, James Miller ..... 539
Knoeppel, John C. ..... 213
Shed, N. W. ..... 257
Spearman, Benjamin ..... 496
Weber, William ..... 36


## P


Pangborn Sand Blast Tumbling Barrel.... 492
Parsons' Steam Turbine, Making a Pattern for ..... 499
Paxson Co., J. W., Liquid Core Binders. 493
Patina, Artificial. ..... 360
Pattern-Drawing Device. ..... 433
Pattern for Burring Machine..... 198
Pattern Plates for Molding Machine Work. 259
Pattern Storage, Practical System for.... 151
Pattern for a Parsons' Steam Turbine... 499
Patternmaking Economies and Developments. ..... 352
Patterns and the Cost of Production..... 116
Patterns for Machine Molded Gears..... 511
Patterns, How to Paint..... 336
Pawling & Harnischfeger Co. Foundry Grab Bucket. ..... 255
Paxson Co., J. W. ..... 121
Paxson Co.'s Extensions..... 210
Peerless Motor Car Co.'s Aluminum Foundry, Cleveland, O. ..... 141
Permanent Mold for Casting Copper..... 415
Permanent Molds, Construction and Methods of Operating..... 173
Permanent Molds, Latest Development of. 173
Permanent Molds, Machine for Casting Projectiles. ..... 173
Peterson-National Co. ..... 428
Pewter. ..... 46
Phosphate of Gold Solution..... 362
Phosphor Bronze, Hard..... 282
Phosphorized Alloys ..... 369
Phosphorus and Anti-Friction Metals..... 71
Phosphorus Hardened Copper..... 231
Pigment Process ..... 361
Pin-Holes in Iron Castings, How to Avoid. 152
Pistons for Gas Engines, Molding of..... 162
Pitting of Nickel Deposits..... 59
Pittsburgh Pneumatic Co., Canton, O., Pneumatic Hammer. ..... 291
Plain Jar-Ramming Machine..... 125
Plating, Preparing Steel for..... 276
Plating to Enlarge Iron and Steel Objects 276
Plating Steel Ball Cups..... 138
Platinum Has Many Uses..... 472
Plumber's Goods, White Alloy for..... 111
Plumbic Bronze. ..... 310
Pneumatic Floor Rammer, Cleveland Pneumatic Tool Co., Cleveland, O..... 296
Pneumatic Hammer for Chipping Steel Castings. ..... 291
Pointers on Nickel-Plating..... 57
Porosity in Brass Castings..... 310
Porous Castings. ..... 72
Porous Smelter Kettles..... 327
Portable Power Squeezer..... 124
Pouring Temperature of Manganese Bronze 487
Power Ramming Molding Machine....39, 381
Power Roll-Over, Direct-Pattern-Draw Machine, Osborn Mfg. Co., Cleveland..... 379
Power Squeezer, Portable..... 124
Power Turn-Over, Power Draft Molding Machine. ..... 121
Practical Hints for Practical Men..... 320
Practice, English Brass Foundry..... 281
Preparations for the Foundrymen's Convention. ..... 328
Preparing Steel for Plating..... 276
Pressure Casting, Increase of Density in.. 311
Prevention of Accidents in Steel Foundry 535
Prevention of Foundry Accidents..... 220
Proceedings of American Foundrymen's Convention at Buffalo..... 441
Process, Pigment. ..... 361
Producing Colors by Electro-deposition... 524
Production of Artistic Bronze Castings... 41
Production of Zinc..... 5
Propeller Blades, Aluminum..... 193
Propellers, Manganese, Corrosion of..... 122
Protection for Foundry Employes..... 293
Protection Hoods for Grinding Wheels... 381
Protecting Wounds ..... 423
Purifying Scrap Copper..... 414


## Q


Quick-Detachable Grab Bucket, Whiting Foundry Equipment Co., Harvey, Ill... 170


## R


Radiator Foundry, Continuous Operations in a ..... 1
Radiator Plant of Kewanee Boiler Co., Kewanee, Ill. ..... 1
Reactions in Electric Furnaces..... 428
Recent Applications of Titanium..... 232
Recovering Metal from Foundry Refuse.. 495
Recovery of Iron from Foundry Refuse... 161
Red Brass, Free-Cutting..... 148
Red Brass Scrap..... 73
Reel Type Core Oven..... 295
Refinishing Steel Knives ..... 517
Refractory White Metals..... 231
Relief for Cyanide Sores..... 423
Removing Hard Enamel..... 94
Repairing the Cupola Lining..... 319
Replating Ware ..... 320
Resistance of Wire..... 139
Rich Color on Castings..... 310
Risers on Molds..... 133
Rockwell Furnace Co, New York City, Reel Type Core Oven..... 295
Roechling-Rodenhauser Electric Induction Furnace ..... 357
Roll Difficulties, Steel ..... 510
Roller-Ramming and Pattern-Drawing Molding Machine, Snead Iron Works, Jersey City, N. J..... 435
Rose Gold Finish..... 276
Rough Treads on Chilled Wheels..... 488
Royal Copper Finish..... 233
Royal Silver Dip..... 139


## S


Safeguarding Foundry Employes from Injury . ..... 178
Sand Blast Machine, Cleveland-Wadsworth 380
Sand-Blasting Machine, Test Results of a. 52
Sand Blasting Room ..... 201
Sand Blast Tumbling Barrel, Pangborn... 492
Sand Cores, Comparison of Green and Dry 208
Sand for Aluminum Castings..... 478
Sand Grinding Machine for Steel Foundry 407
Sand Mixtures for Cores for Brass..... 111
Sand Molds for Casting Pure Copper..... 229
Sanitary Drinking Fountain, Ice-Cooled... 336
Scientific Management for Casting Shops.. 47
Scientific Management of a Foundry Cupola ..... 408
Scrap, Solid Castings from..... 193
Scrap Wire Versus Ingot Copper..... 529
Segregation and Shot in Iron..... 159
Segregation of Lead ..... 529
Selecting Mixtures of Iron..... 314
Semi-Steel ..... 75
Semi-Steel, Brief Discussion of..... 157
Sheet Steel Products, Galvanizing of Small 134
Sherardizing Process ..... 91
Shipments of Molding Sand..... 258
Shockless Jar-Ramming, Roll-Over and Pattern Drawing Machine ..... 253
Shot in Cast Iron, Origin of..... 516
Shotting Copper and Nickel..... 529
Show Room for Foundry Equipment..... 414
Shrink-Holes in Cast Aluminum, Filling of 193
Shrinkage Difficulties ..... 528
Shrinkage in Globe Valve Bodies..... 56
Shrinkage of Copper Castings..... 231
Silicon, Aluminum and Lead in Brass... 230
Silicon in Copper Alloys..... 110
Silver Bronze ..... 148
Silver, Casting of ..... 417
Silver Etching, Solution for..... 362
Silver Finish, Oxidized..... 424
Silver Plating, Solution for..... 274
Silver Solution ..... 275
Silver Solution for a Heavy Deposit..... 138
Silvering Formula ..... 234
Simple and Efficient Skimming Gate..... 197
Simple Strainer Gate ..... 534
Sivyer Steel Casting Co., Milwaukee, Wis. 339
Skim Gate, Effective ..... 537
Skimming Gate ..... 197
Slag, Excessive ..... 306
Slag Flowing from the Tap Hole..... 314
Slag in the Cupola, Excessive..... 201
Sly, W. W., Increases Manufacturing Facilities . ..... 468
Sly Sand Blast ..... 35
Sly Sand Blast Installations..... 359
Smelter Kettles, Porous ..... 327
Smith, J. D., Foundry Supply Co., Cleveland, O., New Installation of Foundry Equipment . ..... 291
Smith's Bearing Bronze..... 149
Smoke Stacks, Iron, Molding of..... 202
Snow Flake Finish ..... 517
Soaking Pit Covers, Castings for..... 469
Soft Castings, Hard Scrap for..... 421
Soft Solder ..... 139
Soft White Metal Pattern Alloys..... 148
Solder for Aluminum ..... 380
Solder for Soft Metals..... 148
Solder, New Aluminum ..... 439
Solder, Soft ..... 139
Solid Castings from Scrap..... 193

Solution for Electro-Galvanizing..... 362
Solution for Nickel Stripping..... 275
Solution for Silver Etching..... 362
Solution, Gold Bronze..... 205
Solution, How to Operate a Brass..... 276
Solution, Phosphate of Gold..... 362
Solution, Silver ..... 275
Solution, Trouble with a Nickel-Plating.. 275
Solutions for Silver Plating..... 274
Some Causes of Blow-Holes..... 390
Sound Castings, Difficulties in Making.... 524
Special Rigging and Equipment for the Foundry . ..... 215
Specifications for Steel Castings, Data Sheets Nos. 121 and 122, September, 1912.
Specific Gravity, Notes on, Data Sheets Nos. 123 and 124, October, 1912.
Spelter Solder, Data Sheet No. 115, June, 1912.
Spongy Iron Difficulties..... 132
Spotted Nickel-Plated Surface..... 275
Sprayer, Core and Mold..... 80
Standard Methods for Determining Constituents of Foundry Coke, Data Sheets Nos. 125 and 126, November, 1912.
Standard Methods for Determining the Constituents of Foundry Coke, Data Sheet No. 127, December, 1912.
Standard Specifications for Steel Castings, Data Sheets Nos. 121 and 122, September, 1912.
Statistics of the American Foundry Industry . ..... 329
Steam Metal, Formula for..... 18
Steel Ball Cups, Plating..... 138
Steel, Casting Brass on..... 417
Steel Castings for the Panama Canal.... 349
Steel for Plating, Preparation of..... 276
Steel for Castings, Basic Open-Hearth... 523
Steel Castings, Furnace for Annealing... 79
Steel Castings, Made by the Crucible Process . ..... 339
Steel Castings, Standard Specifications for, Data Sheets Nos. 121 and 122, September, 1912.
Steel Flasks, Manufacture of, at Sterling Wheelbarrow Co., West Allis, Wis..... 437
Steel Foundries, Prevention of Accidents in . ..... 535
Steel Foundry Laboratory..... 195
Steel Foundry Sand Grinding Machine... 407
Steel Hooks, Finishing of..... 321
Steel Knives, Refinishing of..... 517
Steel, Melting of, in a Brass Furnace.... 200
Steel Molds, Wash for..... 537
Steel Plate, Sulphide Finish on..... 204
Steel Roll Difficulties ..... 510
Steel Strips, Nickel-Plating of..... 322
Steel, Strong Iron Without..... 262
Steel Tubes, Nickel-Plating ..... 517
Sterling Wheelbarrow Co., West Allis, Wis., Steel Flasks ..... 437
Frederic B. Stevens Co., Detroit, Mich., Mechanical Electroplating Machine..... 169
Storage Bins, Arrangement of..... 432
Storage for Patterns, Practical System... 151
Storage Space, Data Sheet No. 119, August, 1912.
Stove Castings, Plates for..... 259
Stove Plate, Clean ..... 356
Strainer Gate, Simple ..... 534
Strength of Crane Chains, Data Sheet No. 116, June, 1912.
Strength of Manila Rope, Data Sheet No. 116, June, 1912.
Stripping Solution, Nickel..... 275
Strong and Cheap Alloy..... 149
Strong Iron Without Steel..... 262
Substitute Alloy for Brass..... 478
Suggestions for Casting Manganese Bronze 282
Suggestions for Preventing Foundry Accidents . ..... 178
Suggestions for Training Foundry Apprentices . ..... 347
Sulphide Finish on Steel Plate..... 204
Sulphur, High ..... 337
Sulzer Bros. Iron & Brass Foundry at Winterthur, Switzerland ..... 103
Swedish Crucible Steel Co., Detroit, Mich. 243
Sweep-Molding a Circular Bed Plate..... 163
System for Pattern Storage..... 151

T

Tabor Jar-Ramming Machine..... 253
Tap Hole, Slag Flowing from..... 314
Taylor & Boggis Foundry Co.'s New Plant, Cleveland ..... 283
Temperature Measurements, Data Sheet No. 113, March, 1912.
Test Results of a Sand-Blasting Machine 52
Tests of Chillable Iron ..... 264
Tests of Monel Metal ..... 505
Thermal Efficiency of Foundry Cupolas.. 408
Thin Chinese Castings..... 197
Thin Coatings ..... 321
Thirty Years in the Foundry Trade..... 208
Tilting Cupola Spout ..... 181
Time Lost Expressed in Dollars and Cents 314
Tin, Disease of ..... 51
Tin Pest ..... 51
Tinning Gray Iron Castings..... 140
Tissiers Metal ..... 56
Titanium, Recent Application of..... 232
Training of Foundry Apprentices..... 347
Transfer of Ink Prints..... 93
Treatment of Cyanide Eruptions..... 423
Treatment of Scalds..... 424
Tropenas Converter Plants..... 35
Tropenas Converters in the Canal Zone.. 349
Trouble With a Nickel-Plating Solution.. 275
Tubes, Nickel-Plating Steel ..... 517
Tubs, Brass Molders' ..... 149
Tuohy Interchangeable Flask..... 540
Turbine-Driven Blower Unit ..... 78
Tuyeres for Blast Furnace..... 73
Twisted Steel Gaggers ..... 492
Types of Electric Furnaces for Melting Brass . ..... 485
Typical Cast Iron Uses and Applicable Tests . ..... 429

U

Uncommon Job for the Foundry..... 55
Union Steel Casting Co.'s Open-Hearth Plant at Pittsburgh..... 25
United States Molding Machine Co. Jar-Ramming Machine ..... 256
Unveiling of Martin Fox Memorial..... 219
U. S. Molding Machine Co., Cleveland, Ohio, Combination Molding Machine... 167
Use of Compressed Air in Foundry Practice . ..... 519
Use of Gas Lamps ..... 514
Use of Iron and Steel Briquettes ..... 106
Use of Improper Sand ..... 418
Use of Plates for Stove Castings..... 259
Use of Slide Rule for Piecework Prices in a Casting Plant ..... 6
Useful Formulas for the Foundryman, Data Sheet No. 110, March, 1912.
Useful Information for the Brass Foundryman, Data Sheet No. 106, January, 1912.
Useful Information for the Foundryman, Data Sheet No. 105, January, 1912.
Useful Information for the Foundryman, Data Sheet No. 119, August, 1912.
Useful Information for the Foundryman, Data Sheet No. 116, June, 1912.
Useful Information for the Brass Foundrymen, Data Sheet No. 128, December, 1912.
Uses and Applicable Tests of Cast Iron.. 429
Uses of Platinum ..... 472
Using a Skeleton Pattern for Heavy Turbine Casting ..... 277
Utilizing Floor Space ..... 359

V

Valves, German Silver for..... 310
Vulcan Engineering Sales Co..... 125

W

Wadsworth Core Equipment ..... 35
Wash for Steel Molds ..... 537
Water in the Cupola Blast..... 539
Wear of Bronzes ..... 418
Wearing Qualities of Bronzes ..... 463
Webb Mfg. & Supply Co., J. F., Davenport, Ia., Molding Machine..... 381
Weighing Iron Mixtures ..... 83
Weights of Different Fuels and Space Required for Storage, Data Sheet No. 119, August, 1912.
Weights of Iron Castings, Formulas for Finding the, Data Sheets Nos. 117 and 118, July, 1912.
Weights of Iron Castings, Formulas for Finding the, Data Sheets Nos. 113 and 114, May, 1912.
Weights of Iron Castings, Formulas for Finding the, Data Sheets Nos. 107 and 108, February, 1912.
Well-Arranged Sand Blast Department... 283
Well-Arranged Storage Bins ..... 432
Well-Equipped Milwaukee Gray Iron Foundry . ..... 419
White Alloy for Plumbers' Goods..... 111
White Metal ..... 18
White Metal Alloy, Cheap..... 528
White Metal, Excessive Shrinkage of..... 282
White Metals for Engines, Experimental Tests of ..... 482
White Metal Pattern Mixture ..... 418
White Metals, Refractory ..... 231
Whiting Foundry Equipment Co., Harvey, Ills., Quick-Detachable Grab Bucket... 170
Wightman & Richards ..... 495
Wire Resistance ..... 139
Wire Scratch Brush, Simplex Brush Co., Cleveland, O. ..... 295
Wood Polishing Wheel Difficulties..... 93
Works of Art, Casting, in Bronze..... 18
Wrought Iron, Casting, in Cast Iron.... 176

Y

Yellow Brass ..... 528
Yellow Brass, Flux for ..... 149

Z

Zinc and Aluminum Alloys ..... 468
Zinc, Production of ..... 5

# Authors' Index to Volume XL

## January---December, 1912

B

Barr, W. H., Copper Alloys for Motor Car Service ..... 525
Belden, A. W., Investigation of the Iron Melting Problem ..... 456
Bengough, G. D., Effect of High Temperature on Copper Alloys..... 108
Best, W. N., Liquid Fuel in the Foundry 489
Binns, J. B., Patterns and the Cost of Production . ..... 116
Buchanan, J. F., Uncommon Job for the Foundry . ..... 55
Bull, R. A., Eight-Hour Shift in the Steel Foundry ..... 461

C

Clamer, G. H., New Electric Furnace for Melting Brass ..... 483

D

Dwyer, Pat, Should Risers on Molds be Covered? . ..... 133

E

Eastham, John, Sweep-Molding a Circular Bed Plate ..... 163
Escher, M. A., Use of Iron and Steel Briquettes . ..... 106
Estep, H. Cole, Manufacture of Aluminum Match-Plates . ..... 221

F

Findley, A. I., The Foundry and Available Pig Iron Supply ..... 532

G

Gillett, H. W., Pouring Temperature of Manganese Bronze ..... 487
Goldsmith, A. L., Instruction for Making and Casting Nickelene or Silver Metal 351
Goldsmith, A. L., Brass Castings for Hydraulic Pressure ..... 232
Gowland, W., Early History of Copper and Its Alloys ..... 95

H

Hammond, Edward K., Scientific Management of a Foundry Cupola..... 408
Hansjosten, J. H., Cleaning Nickel Solutions ..... 361
Hering, Carl, New Electric Furnace for Melting Brass ..... 483
Horne, E. B., Molding Gas Engine Pistons ..... 162
Horne, J. W., Suggestions for Training Foundry Apprentices ..... 347
Horner, Joseph, Making Patterns for Machine Molded Gears—No. I..... 511
Horton, J., British Foundrymen's Conference at Cardiff ..... 370

K

Karr, C. P., Difficult Art of Casting German Silver ..... 486
Keep, W. J., Cast Iron for Copper-Plating ..... 60
Keep, W. J., Clean Stove Plate..... 356
Keep, W. J., Difficulties in Making Sound Castings ..... 524
Keep, W. J., Leaky House Heating Boiler Castings ..... 391
Keep, W. J., Operating a Cupola..... 262
Keep, W. J., Repairing the Cupola Lining 319
Keep, W. J., Recovery of Iron from Foundry Refuse ..... 161
Keep, W. J., Influence of Heat on Castings ..... 8
Keep, W. J., Weighing Iron Mixtures.. 83
Keep, W. J., Hard Scrap for Soft Castings ..... 421
Keep, W. J., High Sulphur ..... 337
Keep, W. J., Porous Smelter Kettles..... 327
Keep, W. J., Slag Flowing from the Tap Hole ..... 314
Keep, W. J., Dull Iron and Cupola Bridging ..... 391
Keep, W. J., Excessive Slag ..... 306
Keep, W. J., Expansion of Cast Iron.... 83
Keep, W. J., Fire Brick Tapping Hole... 17
Keep, W. J., Foundry Roof..... 46
Keep, W. J., Gray Iron Castings for Chemical Work ..... 394
Keep, W. J., Water in the Cupola Blast. 539
Kershaw, John B. C., New Method of Heating Crucibles with Gas..... 50
Kline, Geo. C., Tilting Cupola Spout..... 181
Knoeppel, C. E., Efficiency Movement in the Foundry ..... 47

L

Liggett, Thomas Jr., Sherardizing Process 91
Longmuir, Percy, Deoxidation of Copper and Its Alloys ..... 460

M

McLain, David, Mixing and Melting Iron Scientifically ..... 157
Magruder, W. T., Test Results of a Sand-Blasting Machine ..... 52
Miller, H. F. Jr., Making Basic Open-Hearth Steel for Castings..... 523
Moldenke, Richard, Commercial Tendencies in Malleable Practice..... 431
Moldenke, Richard, Mottled Malleable Iron 132
Moldenke, Richard, How to Melt Iron to Obtain the Best Results..... 503
Munnoch, P., Pertinent Suggestions for Cupola Operators ..... 66
Murray, Arthur F., Use of Compressed Air in Foundry Practice..... 519

N

Nall, Jabez, Building an Intricate Burring Machine Pattern ..... 193
Nelson, Guy W., The Prevention of Accidents in Steel Foundries..... 535
Nold, S. E., What Should a Cost System Accomplish? ..... 127

O

Otto, W. S., Economical Operation of Molding Machines ..... 392

P

Pettinos, Charles T., Mining and Sorting Graphite in Far-Off India..... 315
Ploehm, John, Open-Hearth Furnace Design and Manipulation ..... 464
Porter, John Jermain, Typical Cast Iron Uses and Applicable Tests..... 429
Primrose, H. S., Discussion of Modern Brassfounding ..... 363

R

Reddy, B. H., Operation of Small Open-Hearth Furnaces ..... 112
Rhead, E. L., Segregation and Shot in Iron ..... 159
Riepen, Walter E., Mottled Malleable Iron 263
Robinson, J. D., Molding a Water-Cooled Gas Engine Cylinder ..... 426
Rowsbar, Seymour W., Decorative Green Finishes ..... 360
Rowsbar, Seymour W., Equipment and Management of Nickel Baths—No. 1... 515
Rowsbar, Seymour W., Operation of Duplex Copper Baths ..... 137
Rowsbar, Seymour W., Practical Hints for Practical Men..... 320
Rowsbar, Seymour W., Hot Cyanide Copper Solution ..... 90
Rowsbar, Seymour W., Solutions for Silver Plating ..... 274
Rowsbar, Seymour W., Electro-Deposition of Brass ..... 233
Rowsbar, Seymour W., Few Pointers on Nickelplating ..... 57
Rowsbar, Seymour W., Finishes for Nickel, Copper and Brass ..... 233
Rowsbar, Seymour W., Medical Hints for the Plater ..... 422

S

Schofield, T. R., Patternmaking Economies and Development ..... 352
Searle, Alfred B., British Methods for Testing Molding Sands..... 401
Shed, N. W., Cracks in Chilled Wheels.. 117
Shed, N. W., Air Furnace Practice..... 83
Shed, N. W., How to Avoid Pin Holes in Iron Castings..... 152
Shed, N. W., Spongy Iron Difficulties... 132
Shed, N. W., Shrinkage in Globe Valve Bodies ..... 56
Shed, N. W., Dull Iron..... 80
Shed, N. W., Excessive Slag in the Cupola ..... 201
Shed, N. W., Melting Borings ..... 68
Simeon, Charles J., Scientific Operation of a Foundry ..... 6

T

Tryon, W. L., Formulas for Finding the Weights of Iron Castings, Data Sheets Nos. 107 and 108, February, 1912; Nos. 113 and 114, May, 1912; Nos. 117 and 118, July, 1912.
Tryon, W. L., Methods of Finding the Area of Irregular Figures, Data Sheet No. 111, April, 1912.
Tryon, W. L., Method of Finding the Center of Gravity of Irregular Figures, Data Sheet No. 112, April, 1912.
Tryon, W. L., Notes on Specific Gravity, Data Sheets Nos. 123 and 124, October, 1912.
Tupper, C. A., Making a Pattern for a Parsons Steam Turbine ..... 499
Tuttle, H. N., Molding Iron Smoke Stacks 202
Tuttle, H. N., Filling Shrink-Holes in Cast Aluminum ..... 404
Tuttle, H. N., Practical Pattern Storage System ..... 151

V

Vickers, C., Casting Copper in a Permanent Mold ..... 415
Vickers, C., Casting Works of Art in Bronze ..... 18
Vickers, C., Results of Manganese Bronze Experiments ..... 147
Vickers, C., New Alloy of High Tensile Strength ..... 107
Vickers, C., Production of Artistic Bronze Castings ..... 41
Vickers, C., Molding Artchitectural Bronze Castings ..... 227
Vickers, C., Molding Ornamental Bronze Castings ..... 187
Vom Baur, C. H., Electric Induction Furnace for Cast Steel ..... 357

W

Webster, F., The Buffalo Metal Fest from Two Angles ..... 531
Webster, F., Galvanizing Small Sheet Steel Products ..... 134
West, Thomas D., Results of a Series of Chillable Iron Tests..... 264
West, Thomas D., New Processes for Chilling Gray Iron Castings..... 244
Whitney, Asa W., Control of Mixtures for Cast Iron Car Wheels..... 153
Whitney, Asa W., Rough Treads on Chilled Wheels ..... 488
Woods, N. W., Foundry Ladles..... 152


# Data Sheets, Volume XL

## January---December, 1912

No. 105, January, 1912.—Useful Information for the Foundryman.

No. 106, January, 1912.—Useful Information for the Brass Foundryman.

Nos. 107 and 108, February, 1912.—Formulas for Finding the Weights of Iron Castings.

No. 109, March, 1912.—Formulas for the Brass Foundryman.

No. 110, March, 1912.—Useful Formulas for the Foundryman.

No. 111, April, 1912.—Methods of Finding the Area of Irregular Figures.

No. 112, April, 1912.—Method of Finding the Center of Gravity of Irregular Figures.

Nos. 113 and 114, May, 1912.—Formulas for Finding the Weights of Iron Castings.

No. 115, June, 1912.—Formulas for the Brass Foundryman.

No. 116, June, 1912.—Useful Information for the Foundryman.

Nos. 117 and 118, July, 1912.—Formulas for Finding the Weights of Iron Castings.

No. 119, August, 1912.—Useful Information for the Foundryman.

No. 120, August, 1912.—Formulas for the Brass Foundryman.

Nos. 121 and 122, September, 1912.—Standard Specifications for Steel Castings.

Nos. 123 and 124, October, 1912.—Notes on Specific Gravity.

Nos. 125 and 126, November, 1912.—Standard Methods of Determining the Constituents of Foundry Coke.

No. 127, December, 1912, Standard Methods for Determining the Constituents of Foundry Coke.

No. 128, December, 1912, Useful Information for the Brass Foundryman.